MEMORIAL HALL

AN HISTORIC PHILADELPHIA EXHIBITION SPACE
A PAINT ANALYSIS OF THE GREAT HALL

Jessica H. Senker

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Supervisor
Roger W. Moss, Ph.D.
Adjunct Professor of Architecture

Reader
Frank G. Matero
Associate Professor of Architecture

Graduate Committee Chair
Frank G. Matero
Associate Professor of Architecture

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Introduction

This report is a study of the interior finishes of the Great Hall of Memorial Hall. The study examines the multiple finishing campaigns of both the ornate plaster and metal work in the space. Archival research was undertaken to fully understand the building's past and present appearance and use. With this knowledge, analyses of extracted samples were undertaken at the Architectural Conservation Laboratory at the University of Pennsylvania. The compilation of this research and analyses was done to provide information about the finishes of this grand exhibition space.

When selecting the site to conduct a paint analysis for my thesis, I had two qualifications that I wanted to fulfill. The first was to find a property within the boundaries of the City of Philadelphia. The second was to be inspired by my subject property, through its architectural mastery and its physical purpose. My reasoning for trying to fulfill these criteria was to be energized and passionate about the thesis that I was to undertake, while also contributing something to the City of Philadelphia.

Once Memorial Hall in Fairmount Park was suggested to me by John Carr of the Fairmount Park Historic Preservation Trust, Inc., I was instantly interested. I was familiar with the park building and was intrigued to learn its history and what type of studies had already been conducted. Through several meetings with staff members of the Fairmount Park Commission and initial investigative work into the past studies and analyses completed on the building, I discovered a partial paint study completed in 1986 and 1988 by Frank S. Welsh. This study was attached to a feasibility report by Atkins Voith and Associates which I will discuss further in this document. The analysis by

Frank S. Welsh was limited due to restricted access to samples from the highest elevations.

I decided to take on the project of analyzing the paint campaigns within Memorial Hall by the need of the City of Philadelphia and Fairmount Park to have a full investigation of the painted finishes in Memorial Hall. I would also be providing visual interpretations of Mr. Welsh's findings from 1986 and 1988 as well as new information from samples that I would gather. However, due to a number of factors, mainly the large scale of the building, it was suggested that my focus for the thesis be the Great Hall which is the central room of the building and boasts its signature domed glass and iron ceiling. Another reason for keeping the focus of this study on the Great Hall was that it was the only space remaining that was minimally altered over the years. The space also serves as a large gathering hall for the public and special events. Therefore, if funds became available for finishes restoration at Memorial Hall, the Great Hall would be the focus of that effort.

Currently, there are discussions of Memorial Hall being turned over to either the Please Touch Museum or the Civil War Museum. The Fairmount Park Commission and the District Police Headquarters would be relocated, and Memorial Hall would receive much needed restoration and new tenants. The prospect of a museum moving back into Memorial Hall is extremely exciting since it would be returning to its original purpose of an exhibition space, and the public would once again have full access to its grandeur and beauty.

My hope is that this thesis will provide information and insight into the painted finishes and overall schemes used in the Great Hall originally and throughout Memorial Hall's 137 years of existence.

Chapter 1
History of Memorial Hall

Fig. 1. Interior of the dome in the Great Hall of Memorial Hall. Philadelphia, PA. (Photograph by the author, 2003.)

Chapter 1
History of Memorial Hall

The groundbreaking and construction of Memorial Hall began on July 4, 1874, and today it remains the only surviving major building from the Centennial Exposition. The City of Philadelphia and the State of Pennsylvania would spend $1,564,398.65 to build the stone, iron, and glass structure.[1] Memorial Hall was constructed to be a permanent feature in Fairmount Park to house the Pennsylvania Museum and School of Industrial Art after the close of the exhibition.

Completed on March 1, 1876, Memorial Hall was a grand gesture on the Centennial grounds.

> The architect was H. J. Schwarzmann; the contractor R.J. Dobbins, both of Philadelphia. The iron-work was furnished by the Edgemoor Iron Company, the Pencoyd Rolling Mills, and the Kitteredge Cornice Company. The stone-work was furnished by the Sargent and Co., the Westham Granite Company, and Excelsior Brick Company. The glass was furnished by Shoemaker and Co., Ward and Co., and J.M. Albertson.[2]

Written by Schwarzmann himself, the following are excerpts from the official description of the building:

> The structure is located on a line parallel with, and northward of, the Main Building. It is elevated on a terrace six feet above the general level of the plateau, the plateau itself being an eminence 112 feet above the surface of the Schuylkill River. The materials are granite, glass, and iron. No wood is used in the construction, and the building is thoroughly fire-proof. The structure is 365 feet in length, 210 feet in width, and 59 feet in height, over a spacious basement 12 feet high, surmounted by a dome. The main front looks southward, and displays three distinctive features:
> First. A main entrance in the centre of the structure, consisting of three colossal arched doorways of equal dimensions.

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[1] John Maass, *The Glorious Enterprise: The Centennial Exhibition of 1876 and H.J. Schwarzmann, Architect-in-Chief* (New York: American Life Foundation, 1973), 46.

[2] Ibid., 192.

Second. A pavilion at each end.
Third. Two arcades connecting the pavilions with the centre.
The central section is 95 feet long, 72 feet high; pavilions, 45 feet long, 60 feet high; arcades, each 90 feet long, 40 feet high.
The dome rises from the centre of the structure to the height of 150 feet from the ground. It is of glass and iron, and of a unique design; it terminates in a colossal bell from which the figure of Columbia rises. A group of colossal size stands at each corner of the base of the dome. These figures typify Industry and Commerce on the South front, and Agriculture and Mining on the north front.
The main entrance opens on a hall 82 feet long, 60 feet wide and 53 feet high,... on the farther side of the hall three doorways, each 16 feet wide and 25 feet high, open into the centre hall; this hall is 83 feet square, the ceiling of the dome rising over 80 feet in height. From its east and west sides extend the galleries, each 98 feet long, 84 feet wide, and 35 feet in height. All the galleries and the central hall are lighted from above; the pavilions and studios are lighted from the sides. The pavilions and central hall are designed especially for exhibition of sculpture.[3]

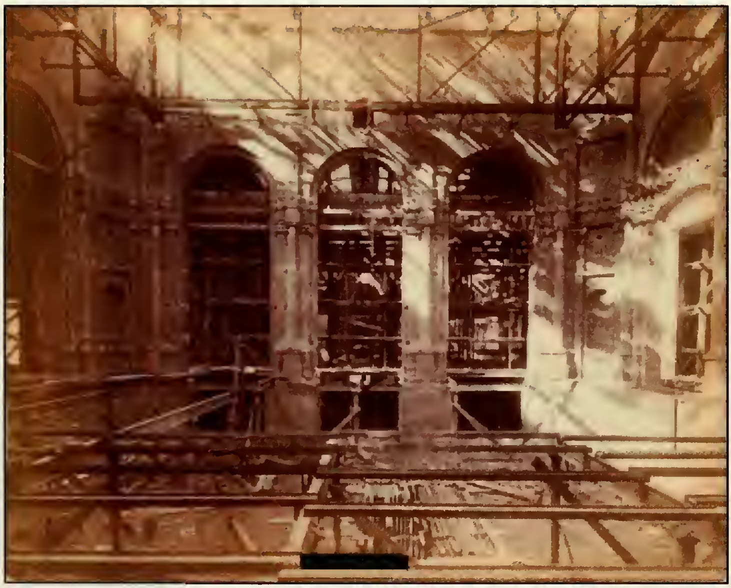

Fig. 2. The Great Hall during construction. (Photograph from the Centennial Photographic Collection, Free Library of Philadelphia, 1876.)

[3] Ibid., 44-46.

Schwarzmann was awarded the commission after winning a competition in 1873 for the design of "one large exhibition building, one portion of which was to be designed as a permanent Art Gallery after the Centennial Exhibition."[4] He was also the Architect in-Chief for the Exhibition when awarded the commission. Twenty days was all it took for Schwarzmann to get the design approval, drawings prepared, write specifications, bid out the work that was needed, and acquire the building contract.[5]

Construction was completed March 1, 1876, and the building would house the art collection for the Centennial Exposition. However, although the building was grand and could accommodate 8,000 people, it was felt that the total exhibition space for works of art was insufficient; therefore a temporary Art Annex was added to provide the space needed for the Centennial.[6] Exhibited in the center of the building under the dome of the

Fig. 3. Centennial Exposition sculpture display in the South Foyer of Memorial Hall. (Photograph from the Centennial Photographic Collection, Free Library of Philadelphia, 1876.)

[4] Rebecca Trumbull, "Memorial Hall: A History," (Philadelphia: Fairmount Park Council for Historic Sites, 1986), 1.

[5] Ibid., 2.

[6] Ibid., 3.

Great Hall were sculptures mostly by American artisans, with a large sculptural group in the center representing "America" which was from the Albert Memorial in Hyde Park, London. The Great Hall housed the sculpture collection and was flanked by picture gallery spaces on either side.[7] The exhibition spaces in both Memorial Hall and the Art Annex were distributed among the participating countries. France, Great Britain, Italy, and the United States dominated the exhibition layout.[8]

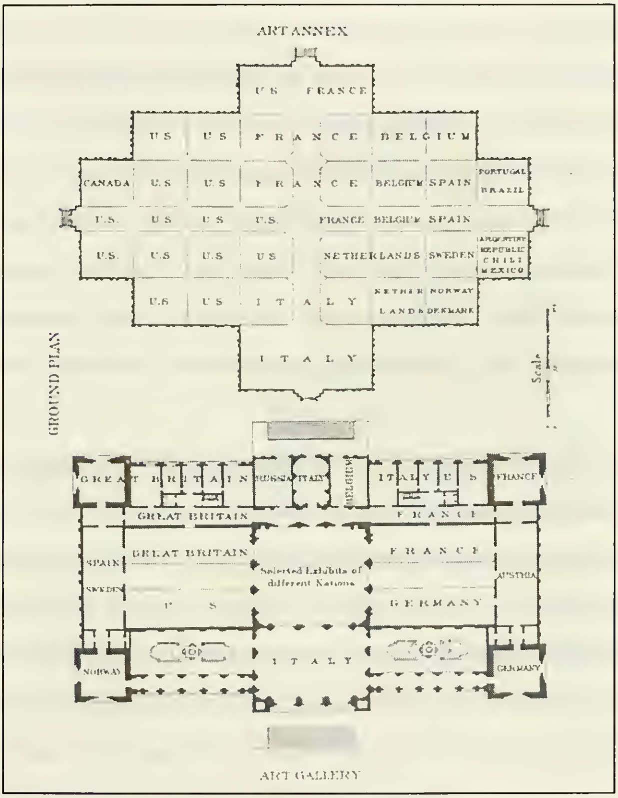

Fig. 4. Exhibition plan for Memroial Hall (Art Gallery) and the Art Annex for the Centennial Exposition. (Photograph from the Centennial Photographic Collection, Free Library of Philadelphia, 1876.)

[7] James D. McCabe, *The Illustrated History of the Centennial Exhibition* (Philadelphia: The National Publishing Company, 1975), 193.

[8] Trumbull, "Memorial Hall: A History," 45.

Once the Centennial Exposition had closed, possession of Memorial Hall was granted through a lease to the Pennsylvania Museum and School of Industrial Arts. During their occupancy, alterations were made to accommodate their needs, but the Great Hall remained virtually unchanged.[9] This tradition of minimally altering the appearance of the Great Hall would continue to the present day. Changes and renovations to Memorial Hall are discussed more thoroughly in this document.

From the time when the School of Industrial Art relocated to 1709 Chestnut Street in 1880, the fate of Memorial Hall would be uncertain. The Pennsylvania Museum would remain in the building for several years; however their growing collections would cause frustration due to the layout, size, and difficult repairs and maintenance needed to sustain the function of the building. Memorial Hall was appreciated as "one of the largest and finest Museum buildings in the country, containing galleries unequalled for light, wall, floor space and general arrangement." Yet as early as the 1900s, the building just could not contain the growing collection and it was felt that it also lacked proper storage for works of art. [10]

Several attempts to alter the building to accommodate the Pennsylvania Museum were made, such as enclosing the two arcades and opening up a space in the basement just under the South Vestibule. These adaptations proved not to be adequate and in 1928 the Museum opened its new facility where it remains today as the Philadelphia Museum of Art. Memorial Hall would continue to house smaller collections of the Museum until 1933 when lack of funds during the Great Depression forced Memorial Hall to close. "By 1935, portions of Memorial Hall were opened, including the library and offices, and the museum exhibits for ten weekends during the summer."[11]

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[9] Ibid., 3.
[10] Ibid.
[11] Ibid., 4.

Beginning in 1949, Fairmount Park began taking an active role in the fate of the building and mandated that one-third of the building be set aside for the creation of a recreation facility, which would open by 1950 for that area of the park. This then caused the Museum to hold an auction in 1954-55 to dispose of some of its smaller remaining collections from Memorial Hall. In 1956, the Fairmount Park Commission took over Memorial Hall in its entirety.[12]

To this point, the Great Hall had survived unaltered. In the period 1959-67, however, Memorial Hall would receive considerable alterations by the Fairmount Park Commission. During this time, repairs were made and rooms were given new purposes. The building would gain a basketball court, volleyball court, pool, offices for park staff, and police headquarters. Hatfield, Martin and White Architects were the architects for the project.[13] Since these alterations took place, the building has continued to serve the public for recreational uses and as the headquarters of the Fairmount Park Commission. The Great Hall and South Foyer are open to the public for tours, events and catered parties. Except for these uses, Memorial Hall currently is under utilized and once again needs quite a few repairs.

While Memorial Hall began its life as a grand exhibition space for the Centennial Exposition, and later the Pennsylvania Museum, current proposals may bring the building back to its original use. With present discussions of either the Please Touch Museum or the Civil War Museum becoming the building's newest tenants, the future use of Memorial Hall may lie in its past.

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[12] Ibid.

[13] Ibid.

1.1
Centennial Exposition

Philadelphia was claimed by many to be the obvious site for the grand exhibition to mark the 100th year of independence for the United States. However, the plan was not initially embraced by all. It required the efforts of "the Hon. John Bigelow, formerly minister from the United States to France; General Charles B. Norton, who had served as a commissioner of the United States at the Paris Exposition of 1867; Professor John L. Campbell, of Wabash College, Indiana; and Colonel M. Richards Mucklé, of Philadelphia,"[14] to capture the public's attention and acceptance of the plan. With the aid of the United States Congress, Fairmount Park in Philadelphia was selected, and the city was granted the charge of hosting the international event known as the Centennial Exposition. However, Congress also stated that the United States should not be liable or held accountable for any related expenses that the exposition may require.[15]

The Congressional Act reads: "An Act to provide for celebrating the one hundredth anniversary of the American Independence, by holding an International Exhibition of Arts, Manufactures, and Products of the Soil and Mine, in the city of Philadelphia, and State of Pennsylvania, in the year eighteen hundred of seventy-six."[16] The Act continues on to describe the make-up of a Centennial Exposition Commission, duties, chain of command, and dates of the event. The Act was passed and the bill was approved by the President on March 3, 1871, therefore becoming law. The first meeting of the Commissioners was assigned to March 4, 1872, and assembled in Philadelphia.[17]

Over the next few years, executive orders and proclamations by the President of the United States were issued to celebrate and direct the proceedings of the International

[14] McCabe, *The Illustrated History of the Centennial Exhibition,* 64.
[15] Ibid., 65.
[16] Ibid.
[17] Ibid.

Exhibition. These orders were also used as press releases to inform the local, national, and international public of the progress being made, and to add excitement to the event. It wasn't until July 4, 1874, that a formal ground breaking took place in Fairmount Park to begin construction of the exhibition buildings. It would be the responsibility of the State of Pennsylvania and the City of Philadelphia to raise the necessary funds, since the federal government would not provide much financial support for the event.

Work on the exhibition buildings pressed forward with much vigor and many observers were in awe of how quickly the buildings were built. "Machinery Hall was the first completed, and this was followed by the Main Building, the Horticultural, Agricultural and Memorial Halls."[18] The Centennial Executive Committee assigned the following exhibition calendar:

> Reception of Article commences January 5, 1876
> Reception of Articles ends April 19th
> Unoccupied space forfeited April 26th
> Main Exhibition opens May 10th
> Grand Ceremonies on Exhibition Grounds, July 4th
> Trials of Harvesting Machines, June and July
> Trials of Steam-Plows and Tillage Implements, September and October
> Exhibit of Horses, Mules, and Asses, September 1st to September 15th
> Exhibit of Horned Cattle, September 20th to October 5th
> Exhibit of Sheep, Swine, Goats and Dogs, October 10th to October 25th
> Exhibit of Poultry, October 28th to November 10th
> Main Exhibition closes November 10th
> Exhibits must be removed by December 31st.[19]

When the exciting day finally arrived for the opening of the grand exhibition, the city was alive with anticipation of the event and the hotels were full with guests. At nine o'clock in the morning, the gates were opened and people pressed in to see what the country and the world had brought them. Over 100,000 visitors attended the commencement ceremonies and heard President Ulysses S. Grant declare the opening of the exhibition.[20]

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[18] Ibid., 85.

[19] Ibid., 86.

[20] Ibid., 101.

Fig. 5. View of opening day of the Centennial Exposition. (Photograph from the Centennial Photographic Collection, Free Library of Philadelphia, 1876.)

Nearly two hundred and thirty six acres of Fairmount Park were covered with exhibition buildings and spaces, with Memorial Hall occupying the southern end.[21] Attendance of the total exhibition was estimated at 8,000,000 and while most observers were pleased with that result, others were slightly disappointed; however the commercial gain was felt to be quite successful. It was the general consensus that the Centennial Exposition proved to be a great success for the country, Pennsylvania, and Philadelphia.[22]

When the exhibition drew to a close there was some remorse that all the exhibition buildings would be torn down, but the attention then turned to the permanent collections that would be housed in Memorial Hall. Memorial Hall would be reopened in May of 1877 as the Pennsylvania Museum and School of Industrial Art. The idea was to model the Museum after the South Kensington Museum in London. Much excitement

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[21] Ibid., 113.

[22] Ibid., 294.

grew over the Pennsylvania Museum and both monetary and artistic donations were received, for it was Memorial Hall that ultimately would memorialize the Centennial Exposition by its permanent beauty.[23]

[23] Ibid., 302.

1.3
Architectural History and Alterations

Schwarzmann's Memorial Hall was built almost exactly as designed. The only major changes made to the building's design during construction were the elimination of some of the decorative elements. This paring down of ornamentation was most likely due to financial constraints.[24] The overall plan of Memorial Hall has remained unaltered and no additions have been made to the structure.

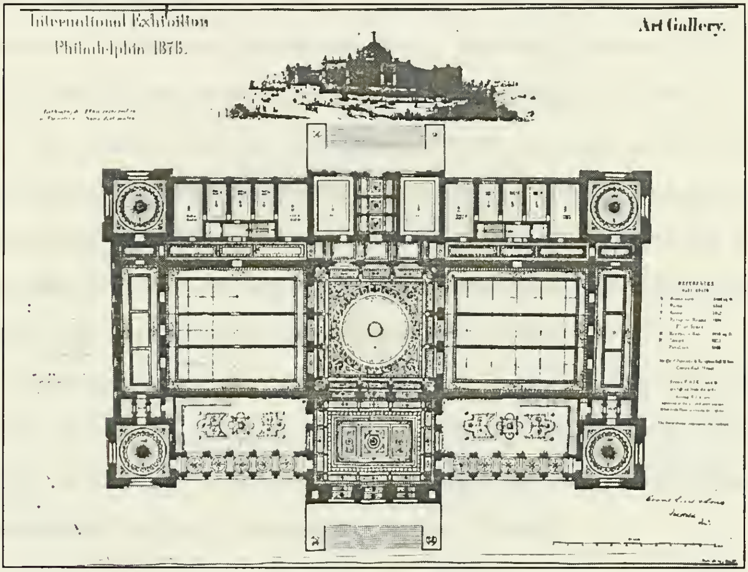

Fig. 6. Lithograph of plan and reflected ceiling plan of Memorial Hall, 1876. (Trumbull, "Memorial Hall: A History," 105.)

Renovations to Memorial Hall have significantly changed some of the interior spaces of the building, but have left the South Foyer and the Great Hall intact. As early as the turn of the twentieth century, the "enclosure of both the eastern and western arcades, and the opening of the basement apartment directly underneath the South

[24] Trumbull, "Memorial Hall: A History," 2.

Vestibule," were completed in order to provide the Pennsylvania Museum with more space for collections. These alterations were in lieu of adding wings to the building that would extend north from the pavilions as recommended in 1900 by the President of the Museum, William Platt Pepper.[25] These alterations changed the South Foyer as well by blocking out the windows opening into the east and west arcades. The Great Hall remained unaffected by the enclosure.

Once the Philadelphia Museum was built for the Pennsylvania Museum, Memorial Hall suffered terrible neglect. The building would only house smaller collections until the middle of the twentieth century. It was the Commissioners of Fairmount Park that attempted to reopen a portion of the building as a recreation facility. This transition would then cause the Pennsylvania Museum to auction the rest of the collections housed in Memorial Hall. When the Fairmount Park Commission took full custody of the building, Memorial Hall needed much repair, particularly the roof structure. In 1959 the building would begin a drastic transformation from a grand exhibition space, to a multi-purpose structure for Fairmount Park.

Several years were invested in the renovation of Memorial Hall and many spaces were altered for new uses. The architects, Hatfield, Martin, and White led the renovation project from 1959 to 1967. The following is a brief description of the alterations that took place during this time as documented by Rebecca Trumbull:

> In 1959, the skylights over the Main Picture Galleries, Small Picture Galleries, Courtyards, corridor and the ten second floor rooms were removed and replaced with a solid roof. In 1961, in addition to the new basketball court in the west Main Picture Gallery, a men's dressing room and showers were installed. Repair work was also done on the heating and ventilating and the electrical systems during this time. In 1962, the installation of the diving and racing pools in the east Main Picture Gallery was accomplished. Additional work on the heating and plumbing was undertaken at this time. In 1967, the major renovation of the western courtyard and arcade and the north rooms of the building into Fairmount Park Police and Administrative offices were undertaken.[26]

[25] Ibid., 3.

[26] Ibid., 4.

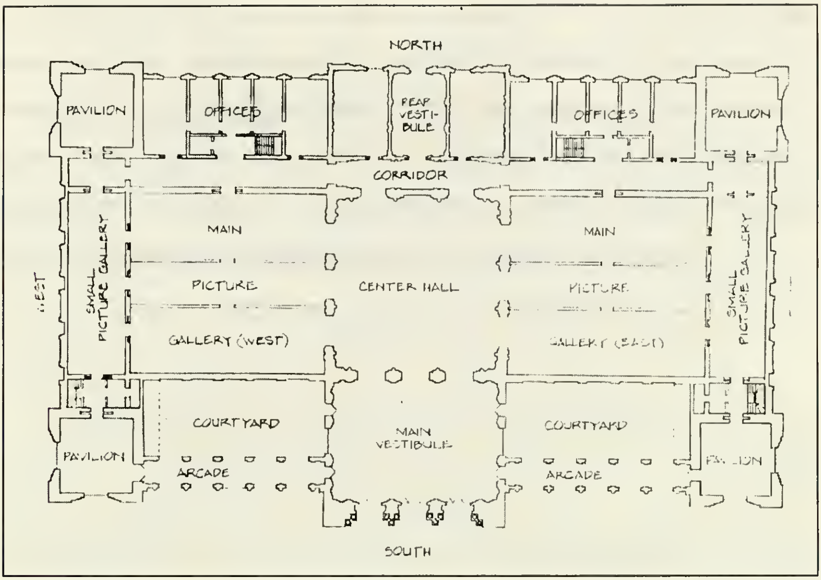

Fig. 7. Plan of Memorial in 1876. (Trumbull, "Memorial Hall: A History," 43.)

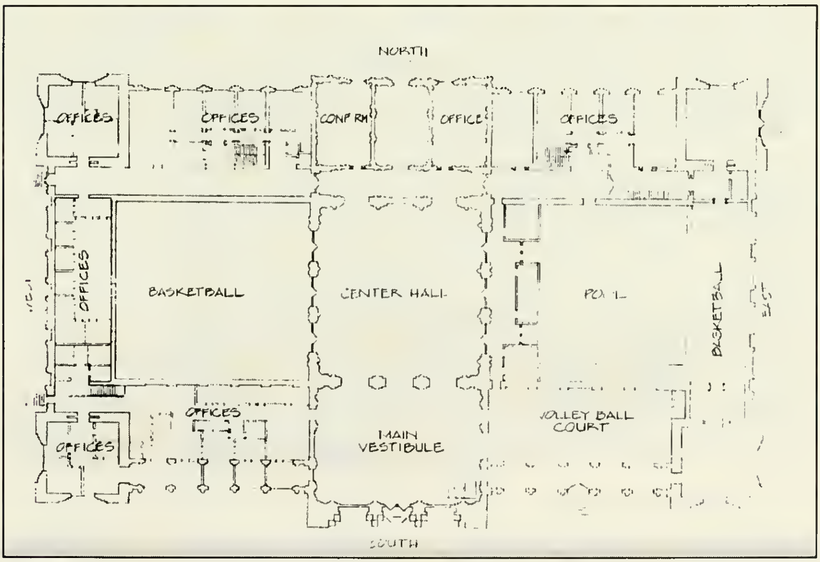

Fig. 8. Plan of Memorial after renovations were made. (Trumbull, "Memorial Hall: A History," 44.)

Within the Great Hall, infill doorways were added in the three archways on the east and west walls. Although exact dates could not be determined for the construction of these doorways, it was this period that Memorial Hall received the most alterations and renovations. However, through all of this change the Great Hall has retained its grand character and ornamentation. The Great Hall has served the Park as a place to hold public and private events, while also providing a maintenance challenge.

1.3
American Paint Industry of the Era

Understanding the history of Memorial Hall was integral to this study, as was a knowledge of the American paint industry during the time of the building's construction. This information was necessary to provide insight into how paint was manufactured and what was available during the late nineteenth century. The firms producing paints locally were also a concern, as they would be the most likely supplier for the paints used in the Great Hall.

The accessibility of materials necessary to produce architectural paints in the mid-nineteenth century was continuously growing and recipes for such were becoming available. Beginning with the manufacturing of pigments, white lead was one of the most common and oldest prepared colorant. It was a focus of this study to understand the importance and commonness of white lead in Philadelphia, since it was presumed to be prevalent in Memorial Hall. Dating back to 1678, the *Dutch Process* for creating lead white remained virtually unchanged until 1811 when the first patent was granted for the manufacture of white lead in the United States. This alternative method of creating the paint as compared to the traditional *Dutch Process* was developed by S. Wetherill, Jr. of Philadelphia.[27] This process as documented by Teresa Osterman Green, in *The Birth of the American Paint Industry*, can be summarized into the following steps:

- melted lead was cast into sheets that would then be rolled into coils and placed into earthen pots;
- loose coils were kept from touching the bottom of the pots where a considerable amount of vinegar was poured in;
- pots were arranged in beds that were sheltered from the exterior elements and

[27] Teresa Osterman Green, "The Birth of the American Paint Industry" (University of Delaware, 1965), 57-60.

layered with boards and dung for about two months;

- the heat from the dung would react with the vinegar and cause evaporation, which would then come in contact with the lead and cause corrosion or oxidation;
- the whitish, brittle, subcarbonate material produced was then mixed with water and passed through mill stones until ground fine, however more coarser particles were washed, and passed through several cisterns until fine;
- once the water was drawn off, the material was placed in kilns for drying to complete the white lead pigment production;
- after kiln dried, the white lead was milled again and linseed oil was added to create a ready-to-use paint.[28]

For many years, the process for making white lead continued as prescribed by S. Wetherill, Jr., until 1840 when a patent was awarded to New York's S. Gardner. His process simplified the Wetherill approach by taking the oxidized lead and "triturating with water in closed leaden cylinders into which carbon dioxide (CO_2) and air at atmospheric pressure were introduced. This method supposedly produced a perfect carbonate of lead. The resultant white lead had a light blue color which disappeared on drying."[29]

The production of white lead expanded throughout the United States, while the Wetherill Company in Philadelphia continued its process until the 1930s.[30] In comparing the production amounts of white lead in the United States, there were 9,000 tons manufactured in 1850, whereas in 1880, 61,739 tons were produced. It wasn't until 1880, that the white lead production began to diminish due to the availability of zinc white.[31]

"In the *Oil and Drug News*, of August 18, 1881, is an historical review of the

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[28] The Wetherill patent information is attached to this document in Appendix A.
[29] Green, "The Birth of the American Paint Industry", 64.
[30] Ibid.
[31] Ibid., 72.

oldest Philadelphia paint houses, which says: Philadelphia boasts of the oldest corroding white lead houses in the United States."[32] Besides the Wetherill company, two other prominent paint manufacturing houses were also listed in Philadelphia, Harrison Brothers and John T. Lewis and Brothers. However, it would be the Wetherill company again, who would invent and be the first to manufacture zinc white in the United States.[33]

The mid-nineteenth century also marked the transition into the modern paint industry in the United States since it was from this point forward that the availability of "pigments, and various chemical intermediates, diverse vehicles, and ready-mixed paints, began.[34] The paint container also played a role in the ease of obtaining varying types of paints, and in much smaller quantities. The patent awarded in 1867 to Frederick W. Devoe of New York replaced the kegs and barrels in which paint was formerly sold, and created the pail that could be resealed as well as held with one hand while working. The other benefit to the paint pail was that it could be shipped easily and could be stored for periods of time without deteriorating.[35]

Regarding the early paint manufacturing companies in the area, many combined their efforts and survived well into the twentieth century, and some up to today. As previously mentioned the Wetherill company was a large force in the white lead production in Philadelphia. The company grew to be Wetherill and Sons, Inc. and remained in the family until the 1930s. John Harrison Company was purchased by the DuPont Company when they began manufacturing paint. The New Jersey company of John Lucas, was one of the first to enter into the ready-mixed paint business in 1860.[36]

With the knowledge of how the American paint industry was evolving throughout the nineteenth century, it was understood that there was a great availability and array

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[32] Mrs. S.P. Wetherill, *Samuel Wetherill and the Early Paint Industry of Philadelphia: Written for the City History Society of Philadelphia* (Philadelphia: City History Society of Philadelphia, 1916), 16.
[33] Ibid., 19.
[34] Green, "The Birth of the American Paint Industry", 120.
[35] Ibid., 115-16.
[36] Ibid., 119.

of pigments and mediums in use at the time of Memorial Hall's construction. The large amount of varying colored paints being produced by the late nineteenth century, as well as the large paint manufacturing business in and around Philadelphia, leads to the possibility that the paints used in Memorial Hall were of local production. The hypothesis formed was that the likelihood of finding a lead-based original painted finish was high, and that it may have been from the Wetherill company of Philadelphia.

Chapter 2
Interior Paint Finishes of the Great Hall

Fig. 9. Caryatids in the Great Hall. (Photograph by the author, 2003.)

Chapter 2
Interior Paint Finishes of the Great Hall
2.1 Archival Research

This chapter will discuss the research, methodology, examinations, and analysis of the surface finishes in the Great Hall of Memorial Hall. The Great Hall was chosen as the focus of this study due to the need of the Fairmount Park Commission to have a complete interpretation of the paint schema in the Great Hall. Due to the challenging height to which the dome rises, and the time permitted for such an analysis, the Great Hall is the focus of this study.

Before sampling began, archival research was conducted to understand the space and its possible finishing treatments over time. Repairs to the building as a whole also needed to be researched since such work may have affected the Great Hall. The Fairmount Park Commission archives provided much insight into what repair work had been completed and the financial expenditures by the Park and the City of Philadelphia in trying to maintain Memorial Hall. After the major renovations took place from 1959-1967, there are no records indicating more repair or alterations undertaken until 1975.

A memo from Robert C. McConnell, Director of the Fairmount Park Commission, to Commissioner Frank G. Binswanger, Sr., dated April 12, 1978, briefly summarized the repairs completed and planned for Memorial Hall. Some of the items mentioned are:

- The reglazing of the Memorial Hall Dome which was included in the ceiling repairs inside the Great Hall and was completed September 1976 at total cost of $318,000;
- more roof repairs were completed in that same year totaling $28,865;
- additional roofing work to cost another $85,000;
- the statue atop of the dome was repaired and the base said to be made water-tight at a cost of $8,313;

- improvements for the indoor swimming pool and the volleyball court were in progress in 1978 and costing $82,500;
- the cleaning and repointing of the exterior of Memorial Hall, estimated at $100,000.[37]

In the winters of 1982 and 1983, Warren-Ehret-Linck Company (WELCO) was hired to conduct a series of investigations to determine the causes of water infiltration and damage in the building. Their notes dated January 23, February 3-8, 1982, detail the following observations:

- leaks seen from under the base of the uppermost statue; water drips from various locations of the roof and particularly from the underside of the skylight areas;
- flat built-up sections of the roof lead to more leaks where the water becomes trapped and where there are faulty pitch boxes;
- condensation on glass elements cause water damage due to varying temperatures inside and outside of the building.

A summary of these findings suggest that the swimming pool area has caused considerable damage due to poor climate control and ventilation. Also, stormy weather and debris around the dome added to the water infiltrations into the Great Hall.[38]

WELCO investigated the water problems again on January 27, 1983, and observed some of the following problems on the interior and exterior of the dome area:

- balustrades are missing at various places and are admitting water into the base flashings of the flat built-up roof and water table;
- many cornice brackets will have to be replaced and the condition and support of the cornice itself, evaluated for repair or replacement;

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[37] Robert C. McConnell to Commissioner Frank G. Binswanger, Sr., April 12, 1978, Memorial Hall, Maintenance Folder, Fairmount Park Commission Archives.
[38] Warren-Ehret-Linck Company (WELCO) to Fairmount Park Commission, 1982, Memorial Hall, Maintenance Folder, Fairmount Park Commission Archives.

- ornamental garland wreaths are loose where attached to the belt face of the dome wall;
- preservative coating over dome is pin holed and cracked at points of structural movement, and expansion and contraction;
- dome cornice at top of skylight is loose and admits blowing wind and driving rain;
- main roof of the statue on the dome has split in the copper, admitting water.[39]

A memorandum dated April 30, 1986, from Thomas L. Kline, Park Engineer, to Alexander L. Hoskins, Director of the Fairmount Park Commission, outlines the expenditures and work conducted on Memorial Hall to improve and maintain the building. Below is information provided in a memo that lists work undertaken from 1980 to 1986.

- 1980: Electrical and mechanical work = $22,000.

  Heating work as a structural improvement = $64,000.

  Pipe railing work = $8,300.

  Mechanical work (H.V.A.C) = $83,000

  Roofing work = $273,000.
- 1981: Additional stonework and repointing = $46,000.

  Stonework and repointing = $15,000.

  Gym floor and repointing work = $6,400.
- 1982: Door locking systems = $5,000.
- 1983: Ornamental metal-work restoration (dome and roof) = $1,065,678.

  Installation of sprinkler system = $25,000.

  Improvements (not detailed) = $219,000.

[39] Warren-Ehret-Linck Company (WELCO) to Fairmount Park Commission, 1983, Memorial Hall, Maintenance Folder, Fairmount Park Commission Archives.

- 1984: Electrical supply for computer room = $6,800.
- 1985/86: Mechanical and roofing work = $142,000.

Total..................................$1.96 million.[40]

In addition to these extensive repairs and maintenance that Memorial Hall had received, a paint analysis by Frank Welsh of portions of the Great Hall was conducted in 1986-88. Also there were Plaster Stabilization Projects from 1996 to 2000. Both of these projects are detailed in the following pages, since their scope impacted the project undertaken as discussed in this thesis.

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[40] Thomas L. Kline to Alexander Pete Hoskins, April 30, 1986, Memorial Hall, Maintenance Folder, Fairmount Park Commission Archives.

2.1.1
Previous Paint Study

The Fairmount Park Commission contracted Atkin, Voith and Associates (AVA) in January 1988 to conduct a study on the viability of restoring Memorial Hall for use by large groups and many different types of functions.[41] As a basis of their report, AVA also studied past reports completed on Memorial Hall which would help guide their recommendations for the building. According to the architects, Frank S. Welsh's study was described as the following:

> The initial Welsh Report of 1986 was supplemented with additional work this summer at our request and funded by the Fairmount Park Council for Historic Sites. Although the paint analysis of Memorial Hall cannot be considered complete, his study has helped reveal much about the history of the building and exposes avenues for further research.[42]

From Welsh's reports of 1986 and 1988, are descriptions of stratigraphies of approximately fifty-five samples which were taken from the Great Hall to determine the paint schema of the space. *The samples studied by Welsh were taken only up to the plaster entablature of the Great Hall since the lift provided to him by the park was not able to reach the higher ornamentation and metal work.* His findings of the paint finishes in the Great Hall and South Foyer are discussed in his report to John McIlhenney, the Park Historian, dated October 29, 1986, and later confirmed with little variation in the Atkin, Voith and Associates 1988 feasibility study.[43]

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[41] Within the Atkin, Voith and Associates 1988 report "Memorial Hall: A Feasibility Study for the Restoration and Adaptation of the Major Public Spaces,", are summations of the following studies: "Memorial Hall Building Deficiency Study," by Donald J. Bergman Associates, 1986; "Memorial Hall: A History," by Rebecca Trumbull, October 1986; "Memorial Hall Grounds Master Plan," by Rudy Favretti, 1986; and "Memorial Hall Paint Analysis," by Frank S. Welsh, October, 1986 and August 1988.

[42] Frank S. Welsh, "Memorial Hall Paint Analysis," (Philadelphia: Atkin, Voith and Associates, 1986-88).

[43] Frank S. Welsh to John Mcilhenney, October 29, 1986, Atkin, Voith and Associates, Fairmount Park Commission Archives.

Welsh inspected the extracted samples with a stereo-binocular microscope with 20X to 105X magnification. He viewed these samples in cross-section to determine the color and number of paint layers the room had received. In 1986, he described the first and original layer to be a light yellowish gray with a Munsell notation of either 10YR 8/1 or 10YR 7/1. This first layer was said to be applied without any variation throughout the space. Welsh then described the next layer to be part of an early twentieth century painting campaign which had some polychrome areas. That layer contained a yellowish-white lead color with a Munsell color notation of 10Y 9/1, and some samples having pink, gray, or gold leaf. A third layer which was said to be the latest paint campaign was described as a white oil primer with a pale yellowish pink oil paint finish coat.[44]

At this time, Welsh also discussed his pigment analysis of the original paint layer. By using a Tungsten needle to extract particles from the layer and observe them under a higher magnification of 400X and 1000X with a polarized light microscope, he was able to determine that the particles were white lead pigment and linseed oil medium. Three other colored pigment particles seen were charcoal black, red ochre, and burnt umber. Welsh stated that these pigment particles in combination would create a light gray. He also stated that there was high concentration of oil in the original layer with a higher gloss than a modern semi-gloss paint.[45]

In the 1988, Frank S. Welsh returned and only two samples were taken in the Great Hall. Both samples were extracted from the North wall center and side. These samples shared the same characteristic layering of the samples taken in 1986, but with a slight variation. In the second layer there is mention of not only pink, gray, and gold leaf, but also a medium and dark green coloring. Further description of these additional colors is not given. It is also in the 1988 report that the description of the first layer is changed

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[44] Atkin, Voith, and Associates, "Memorial Hall: A Feasibility Study of the Restoration and Adaptation of the Major Public Spaces," (Philadelphia: Fairmount Park Commission, 1988), Appendix.
[45] Ibid.

to a resin coating on plaster, then either the yellowish-white or the medium green on top. The explanation of the resinous coating, such as a varnish or sealer was that the plaster had to fully set before an application of an oil based paint finish could be applied. The report refers to a statement by Roger W. Moss, that plaster walls could be painted immediately with a distemper which is a temporary coating, and could easily be removed before painting in oils after the plaster had cured.

While the reinvestigation of the paint finishes of Memorial Hall was included in the Atkin, Voith and Associates report of 1988, the Great Hall was not the principal focus. This was probably due to the fact that the Great Hall was a focus of the initial Welsh study and an adequate lift or scaffolding was again not made available to access higher points of the room. It is for this need for the full interpretation of the interior finishes of the Great Hall that determined the focus of this study.

2.1.2
1996-2000 Plaster Stabilization Projects

Today in the Great Hall there is netting placed in many areas to catch any falling plasterwork. The space has been plagued with water damage which continues to be a major headache for the park staff. The roof has been repaired, but water continues to pour into the room during inclement weather. This condition has resulted in emergency plaster stabilization projects that have saved many pieces of ornamental plaster from falling to the ground and possibly injuring someone.

Beginning in 1996, there are memoranda in the Fairmount Park Commission archives that discuss the urgent need to have someone inspect and stabilize the plasterwork in Memorial Hall that is "hanging by a thread over frequented areas of the Hall."[46] The Great Hall and South Foyer were not the only rooms to have extensive water damage occurring, but the greatest threat of failing and possible injuries were more worrisome in these two spaces. The stabilization work -- which was primarily securing areas with netting and removing sections which were about to fail -- was conducted by Anatoli Zolotarev, a decorative plaster restorer. Zolotarev made inspections and stabilized areas throughout the Great Hall, but also remarked that many of the failing areas were from previous repairs. No documentation of these previous plaster repairs in the Great Hall have been found, but it is assumed that this work was done under line items such as "Improvements" or "Maintenance" in Memorial Hall.

The stabilization efforts were revisited in 1997, again by Anatoli Zolotarev. This effort was aimed at emptying the nets of fallen plasterwork as well as installing more netting in other areas of the Hall. It was also at this time that Zolotarev revisited his

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[46]Amy L. Freitag to Phil Stetson, April 18, 1996, Memorial Hall, Plaster Stabilization Folder, Fairmount Park Commission Archives.

previous repairs and made additional minor repairs where necessary.[47] Zolotarev would once again be a key person on yet another campaign of inspections and stabilizations in 2000.

From March 30 through April 12, 2000, the Fairmount Park Historic Preservation Trust, Inc., was contracted by the Fairmount Park Commission to investigate and assess the plasterwork in the Great Hall. The team consisted of: Samuel Y. Harris, Architect, Engineer, and Attorney; John Carr and Kurt Leasure, Architectural Conservators; and Anatoli Zolotarev, Decorative Plasterer Restorer. Their methodology was to review previous reports of the dome, visual inspections of the roof, visual inspections of the interior of the dome with a high-lift (fifty-foot boom reach), and physical inspections of damaged areas by way of sounding with a mallet and opening sections of the plaster and lathe in key areas to determine issues of broken plaster keys and problematic armatures.[48]

The 2000 inspection found that there was further water damage and plaster deterioration subsequent to the investigation in 1997. The roof had continued to allow water to infiltrate the interior of the Great Hall, therefore causing damage to the plasterwork. Using the high-lift, access was available to areas just above the caryatides which were all determined to be metal work and were not cause for any investigation due to the lack of apparent damage. The plasterwork was probed and areas of the projecting cornice and around the bases of the caryatids were opened to determine the extent of the existing damage.

The team found that much of the most severely damaged plasterwork was in the corners of the room, between the upper and lower cornices. The general condition of these areas was the loss of small plaster pieces with the loss of friable plaster surfaces.

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[47] Johnette Davies to Barry Bessler, July 30, 1997, Memorial Hall, Plaster Stabilization Folder, Fairmount Park Commission Archives.

[48] Fairmount Park Historic Preservation Trust Inc., "Memorial Hall: Great Hall Plaster Inspection and Emergency Stabilization," (Philadelphia: Fairmount Park Historic Preservation Trust Inc., 2000).

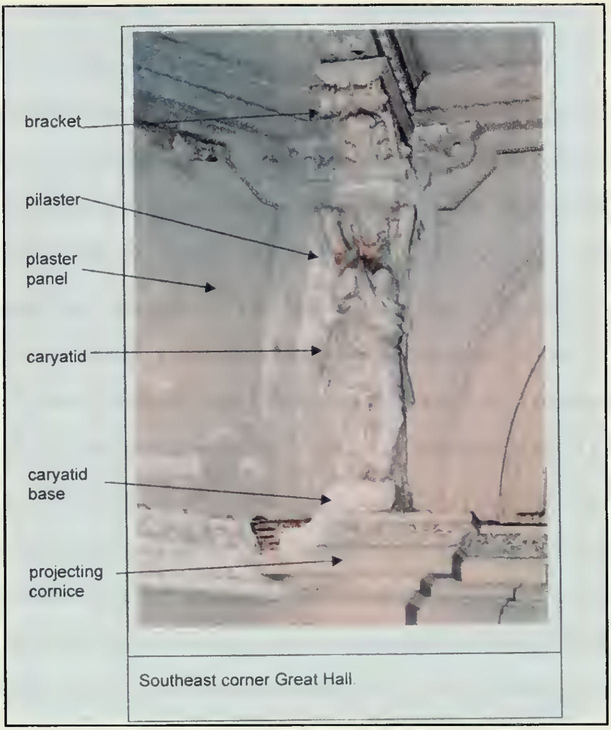

Fig. 10. Plaster damage locations recorded by the Fairmount Park Historic Preservation Trust, Inc., 2000.

More troubling damage -- where larger pieces have either fallen or were almost completely detached -- was the upper cornice of the South Foyer, along the east and west walls, as well as the westernmost archway between the South Foyer and the Great Hall. In each corner, except the northeast, the brackets of the caryatids were detaching from the wall and had large cracks along the top edges. In this report, the Fairmount Park Historic Preservation Trust, Inc. (FPHPT) has outlined possible scenarios for the cause of structural instability:

> First, water infiltration in the plaster that binds the wooden support member to the walls of the bracket will activate the water soluble salts in the gypsum based plaster, weaken the plaster and the plaster element will settle away from the structural support system. Second, of the wooden members within this structural system are exposed to water repeatedly over a long period of time, fungal decay

> will jeopardize the structural integrity of these members, causing settlement of the entire bracket. A third, more likely scenario is that these two processes would occur simultaneously as a result of water infiltration.[49]

Each corner of the Great Hall had varying level of surface damage to the plaster. The areas around the caryatids and projecting cornices were a major concern to the assessment team. In some instances, the wood lathe was made visible to determine if there were also detachment problems with the lathe and wood framing of the structure. These detachment problems were once again linked to water infiltration problems.

FPHPT then expedited immediate treatment to those areas in need of emergency response. The treatment undertaken in 2000 entailed the removal of pieces that posed imminent danger, soft brushes were used to clean areas of surface dirt and friable plaster to make visually monitoring the areas easier, and additional netting that can hold up falling plaster was installed. Wooden barricades were erected along the walls that had the most damage, therefore keeping people further back from the wall and out of possible harm. These wooden barricades along with recommendations to keep the noise levels and amplified sounds down, daily inspections of falling plaster, and proper notification to all visitors to the hall of the potential hazards, were made by Samuel Harris in the FPHPT report.

Harris also defines the origins of the water damage by way of a roof survey. In this survey he states; "the source of the water is primarily from a level of flat roof which is located behind and below the level of the balustrades shown at the base of the dome. The asphalt is highly vulnerable to ultra-violet light and ozone attack. The cracks can and will migrate through the membrane." Harris also writes that the longer water leaks into the building, the further the damage and the higher the ultimate cost becomes to repair and restore the plaster in the Great Hall.[50]

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[49] Ibid.
[50] Ibid.

It is with knowledge of where the most persistent problems have been in the plasterwork in the Great Hall that allowed the sample area to be selected for surveying and sampling for this paint analysis. This information was invaluable in not only understanding more about the construction of the plasterwork, but also what and where repairs were made, and which may affect my own analysis of the Great Hall.

2.1.3
Interior Documentation and Interpretation

While researching documents concerning the construction of Memorial Hall, there was very little mention concerning the finishes for the Great Hall. According to Rebecca Trumbull, "the architect's progress reports provide a general history of the construction of the building; however, they fail to provide much information on the materials and finishes used. For example, the April 8, 1876, progress report says that a contract was awarded for painting, but no paint color was mentioned. The minutes of the Committee on Grounds, Plans, and Buildings dated March 4, 1876, states that Mr. Schwarzmann requested that a gilt molding of 1 ½ inch be put around the ceilings of the offices and Restaurant of Memorial Hall. No other information is available on the location of the Restaurant."[51]

While studying images, such as the photographs on the following page, Trumball stated, "it appears that a dark color highlight paint was used on some of the trim, although according to a contemporaneous publication, this room was painted plain white." The publication Trumbull referred to was James McCabe's *The Illustrated History of the Centennial Exhibition*, whereby McCabe stated, "it is regretted that its beauties were not enhanced by a judicious use of color in its decorations."[52]

More research was conducted by Atkin, Voith and Associates (AVA) in their feasibility report, into the documentation of the paint finishes in Memorial Hall. Their research into the Centennial Photographic Company's stereopticons would reveal more about the original paint scheme. The areas above the corner niches appeared to be outlined in a darker tone, and some of the circular and triangular panels also show darker tones. They interpreted areas higher into the dome, where they believed there

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[51] Trumbull, "Memorial Hall: A History," 2.
[52] Ibid., 26.

Fig. 11. Taken in the South Foyer, looking into the Great Hall. Areas around panels appear to be a darker tone. (Photograph from the Centennial Photographic Collection, Free Library of Philadelphia, 1876.)

Fig. 12. Sculpture exhibition during the Centennial Exposition. Areas of freeze and inset panels appear in a darker tone. (Photograph from the Centennial Photographic Collection, Free Library of Philadelphia, 1876.)

were differences in hue as well, although it was not clear as to if this due to the lighting in the image. The frieze of the cornice also appeared to be of a darker tone than the surrounding areas.[53] Upon further review for this paint analysis of the Great Hall, these statements in the AVA report were reviewed and felt to be plausible, however a complete on-site investigation and the extraction of samples was necessary. Frank S. Welsh also expressed the necessity to take samples from the upper areas that were thought to have varying colors or hues to verify the ideas discussed in the AVA report. It is also important to note that no other descriptive documentation of the paint finish during the Centennial time period was located during this study.

Fig.13. Areas of freize, niche, and inset panels appear in a darker tone. (Photograph from the Centennial Photographic Collection, Free Library of Philadelphia, 1876.)

[53] Atkin, Voith, and Associates, "Memorial Hall: A Feasibility Study of the Restoration and Adaptation of the Major Public Spaces," 20.

Within the AVA report, a Minutes Book of the Committee on Memorial Hall (1894-1911), from City Archives is sited, which indicated that "the Committee on Memorial Hall (a subcommittee of the Fairmount Park Commission) approved the expenditure of $15,000 in 1901 for the "painting of the building, inside and out, including the walls in all the rooms except those used by the Wilstatch Collection."[54] This information represents the second paint campaign within Memorial Hall, when the Pennsylvania Museum inhabited the building.

Fig.14. "The Pennsylvania Museum and School of Industrial Arts" seen on the frieze in the Great Hall, with inset panels appearing in a darkter tone. (Photograph by the Centennial Photographic Collection, Free Library of Philadelphia, 1876.)

The third and surprisingly last paint campaign within the Great Hall of Memorial Hall was completed between 1956 and 1967. It was during this period that the Pennsylvania Museum had removed its collection from the building, and the Hatfield,

[54] Ibid., 56.

Martin and White renovation scheme was already underway. The scheme was, and remains, an overall off-white field with a small area of the metal work painted a crisp blue which accentuates the large, vast space.

With the research conducted previously which had somewhat conflicting interpretations, coupled with research for this thesis study, it was thought that the Great Hall originally had polychromatic areas. Review of images from the Centennial Photographic Company concurred with this idea and created the need for extracting samples for microscopic examination to verify the findings.

2.2
Field Investigation

To understand the interior surface finishes of the Great Hall in Memorial Hall, several techniques were employed. Beginning with identifying sample locations from a well informed understanding of the building's original fabric and later renovations, in-situ examinations were conducted which was followed by the extraction of approximately 115 samples for microscopic analysis. In the Architectural Conservation Laboratory (ACL) at the University of Pennsylvania, bulk samples were initially examined under normal reflected light with an Olympus CH40/31 Polarized Light Microscope to provide a sense of the layering and coloring of the samples. Each sample was then sectioned and embedded in Bio-Plastic liquid casting plastic[55] mixed with its catalyst.[56] Once set, each sample was cut into cross sections using a Buhler Isomet diamond blade and polished with Buehler Micro-polish II, 0.05 micron alumina powder on a micro-cloth.

Once polished, the cross-sections were viewed with a Nikon Alphaphot-2 stereo-binocular microscope using polarized reflected and ultraviolet light. Each layer was examined and recorded according to layer thickness, dirt found, color, and autofluorescence. Representative samples were digitally photographed for use in this thesis.

Other methods used to analyze representative samples, were Fourier Transform Infrared Micro-Spectroscopy (MFTIR), conducted at the Analytical Laboratory of the Philadelphia Museum of Art, and Scanning Electron Microscopy – Energy Dispersion Spectroscopy (SEM-EDS), conducted in the Laboratory for Research on the Structure of Matter (LRSM) at the University of Pennsylvania. Both of these methods were supplemented with chemical analysis conducted in the ACL to determine the pigment

[55] Bio-plastic is a polyester, styrene monomer, methyl methacrylate resin.
[56] Bio-plastic catalyst is methyl ethyl ketone peroxide.

and media within the paint layers. Color matching of each paint layer was identified using the Munsell Color Notation System, CIE, RGB, and CMYK ratios. The notations were gathered by examining representative bulk samples with a Minolta Chroma Meter (CR-241) and under optimum daylight with an Optivisor. Using the Munsell color notation, Benjamin Moore paint numbers and names, a commercially available paint manufacture, were recorded as well. A Benjamin Moore RGM/CMYK ratio chart was also consulted for paint color selection accuracy. Giving all references were necessary for documentation purposes as well as making the color system immediately available for restoration or renovations made to the Great Hall.

2.2.1
Sample Locations

With archival research conducted before sampling, the locations of where to extract samples were easily determined. Having the knowledge that extensive plaster damage and some repairs had been made to the corners and east elevation of the Great Hall, the west elevation was chosen as the focus. The west elevation was not only chosen due to the integrity of the original plasterwork, but also to have a consistent canvas from which the samples would be taken sequentially, beginning above the dado level and ending in the dome area.

The previous paint analyses by Frank S. Welsh included samples above the dado level and up to the caryatids. Higher elevations were not studied at that time due to inadequate equipment to reach those areas. Therefore, plaster samples were again extracted in these previously studied areas to verify earlier findings, and new areas were sampled to complete the entire study of the space. To access these higher points above the caryatides, a Denka Atrium Lift with an 80ft. boom was determined to be the only high-reach capable of accessing the necessary heights, while also having a narrow base which was needed to enter into the building. Although available, the atrium lift rental rate from United Rentals Inc. (only company in the area that owns an atrium lift) proved to be too costly. Therefore, a three tower rolling scaffolding structure was rented that created access to the metal work up to 65 feet. This was determined to be a sufficient height to collect the representative samples needed to complete this analysis.

With the help of the Fairmount Park Historic Preservation Trust, Inc., the scaffolding was erected in increments, over three weeks. John Evans, an employee of the Trust, aided in the sampling process by using Exacto knives and scalpels to extract samples from the plasterwork and metal ornamentation.

Fig. 15. Staff of the Fairmount Park Historic Preservation Trust, Inc. erecting scaffolding for this study. (Photograph by the author, 2003.)

Samples were extracted from the site during January and February of 2003. A complete sample key is included in Appendix B as well as visual representation of the sample sites in Appendix C.

Fig. 16. Sampling process by the author. (Photograph by John Evans, 2003.)

Fig. 17. Sampling process by John Evans. (Photograph by the author, 2003.)

2.2.2
In situ Examinations

In most finishes studies, in-situ examinations are an integral component to the study of the site. Included in these examinations are techniques such as exposures or solvent solubility tests. Although these techniques were attempted in this study throughout the room, the lack of multiple paint layers proved to be an obstacle in utilizing these techniques. Scraping with an Exacto knife and scalpel were helpful while on-site to expose some of the layers of the finishes, but the layers and plaster were friable and therefore did not produce good visual information. Exposures were also attempted by using a fine grit paper along with scraping to create "craters," yet this also proved insufficient.

In conclusion, few and thinly applied finishing layers were too difficult to separate and view in situ. It was determined that extracting samples for microscopic analysis was the only way to identify and view the finish layers in the Great Hall of Memorial Hall.

2.3 Analyses of Selected Samples
2.3.1 Statigraphic Description of Finishes

This chapter will discuss the few finishing campaigns that the Great Hall received, and the identification of the colors using the Munsell Color System. Located in Appendix E of this thesis are the Munsell Color notations mentioned below, along with the CIE, RGB, and CMYK ratios, and then matched to the commercially available paint colors by Benjamin Moore. A Benjamin Moore RGM/CMYK ratio chart was also consulted for paint color selection accuracy.

The colors were identified using several methods. Cross-sections and photomicrographs were re-examined to verify that each displayed consistent information and that additional layers were not overlooked. Representative bulk samples were then scraped down to expose each layer. These layers were examined by a Minolta Colorimeter (CR-241) at the University of Pennsylvania's Architectural Conservation Laboratory, and under optimum daylight exposure with an Optivisor.

The first finish applied to the gypsum surfaces was an oleo-resin or shellac, which was used to size the walls before an oil based paint was applied. This resinous coating can be seen in all of the samples collected with a gypsum substrate. Soon after the shellac or resin mixture was applied, a primer and finish coat of a light yellowish gray, with the Munsell notation of 5Y 9/2 was applied. This paint was also applied to all of the metal work as well during this period. This finish campaign was completed ca.1876 when the building was constructed. It is also possible that the painted finish was not applied until after the Centennial Exposition, since the construction of the building was completed so quickly for the big event. However, there was no visible dirt layer or any cleaving between the shellac coating and the paint, which suggests two finishes applied within a short time span.

Fig. 18. Sample GH 82 at 5X, which shows the original resinous shellac layer, then the following ca.1876, 1901, and 1956-67 paint campaigns. (Photograph by Rynta Fourie and the author, 2003.)

A decorative paint campaign was applied to some of the ornamentation of lower elevations in 1901. The areas included in this decorative paint scheme were the face, crown, and garland that are below the flutes on the pilaster. The acanthus leaves and fleuron of the pilaster's capital were also finished with this decorative paint scheme, which was a gold leaf metallic finish. The metallic finish was characterized by Frank S. Welsh as gold leaf, but it was not analyzed further in this study. The second overall finish that was applied along with the decorative campaign was another light yellowish gray coating in 1901, which was documented in an approved expenditure report of the "Committee on Memorial Hall," where $15,000 was dispersed for the "painting of the building inside and out, including the walls in all of the rooms except those used by the Wilstatch Collection."[57] It was during this period that the Pennsylvania Museum and School of Industrial Arts inhabited the building.

[57] Atkin, Voith, and Associates, "Memorial Hall: A Feasibility Study of the Restoration and Adaptation of the Major Public Spaces," 17.

Fig.19. Although an incomplete stratigraphy, sample GH 19 at 10X, shows the gold leaf decorative paint scheme. (Photograph by Rynta Fourie and the author, 2003.)

The Great Hall was not painted again until the Hatfield, Martin and White renovations were initiated between 1956 and 1967. A bright white primer coat was applied, with a Munsell notation of N.9.5/90% R. When this primer coat was applied there was a large amount of dirt and soot remaining on the surfaces, which then became integrated into this layer. The primer was followed by a finish layer of a light pinkish-white, with a Munsell Color notation of 10YR 9/2. The entire room was painted this color with an additional color applied only to the flat metal area that borders the base of the dome. This additional color was achieved by a deep pale blue primer, Munsell notation of 5B 6/4, and finished with a pale blue finish coating, Munsell notation of 5B 7/4. This third paint campaign is the last coating that the room has received.

In conclusion, the first finish from ca.1876 was an oleo-resin or shellac size applied to the gypsum surfaces, and followed with the entire room being coated with a light yellowish gray. The next paint campaign was in 1901, and consisted of a gold leaf decorative finish applied to few ornamented details, with the overall space painted in another layer of light yellowish gray. The third paint campaign was a bright white primer with a pinkish white finish coat, which was applied between 1956 and 1967, during the renovations made in Memorial Hall. The examination of the paint stratigraphies has verified that the Great Hall has always been an overall monochromatic scheme, with only slight variations in hue. However pigment and media analysis were necessary to determine the composition of the finishes.

2.3.2
Pigment and Media Analysis of Selected Samples

The composition of a painted surface is dependent upon the pigments and media used to achieve the hue. Several external factors also apply to the coloration of the painted surfaces, such as: climate, light exposure, maintenance, elasticity, and application processes. These external factors are especially important to acknowledge and have been accounted for in this study, while attempting to color match or recreate an historic finish. Yet, it is the pigment and media identification that truly informed this study of what the historic paint schemes have been in the Great Hall.

Once the cross-sections were prepared of the samples extracted from the study site, the layering, pigments, and media could be analyzed. While reviewing each paint stratigraphy under polarized reflected light, the samples were grouped and categorized by consistencies. These groupings were useful in identifying representative samples to focus the analysis of the pigment and media components.

Ultraviolet (UV) light was employed to determine which layers had autofluorescent qualities. Autofluorescence "refers to the light emitted by a material when it is exposed to (or excited by) ultraviolet light that has been passed through a filter. Because different materials autofluorescence uniquely, often a material can be identified by its autofluorescent characteristics."[58] Representative samples from the Great Hall were viewed with ultraviolet light and two consistent characteristics were documented. The gypsum substrate of many of the samples had a resinous orange appearance which dully fluoresced a brighter orange when subjected to UV light. This orange tone is indicative of a shellac which historically applied to gypsum plaster walls for as sizing. Size is "any

[58] Dorothy Stewart Krotzer, "St. Alphonsus Church, New Orleans, Louisiana: Documentation, Analysis and Interpretation of Interior Finishes" (University of Pennsylvania, 2001), 137.

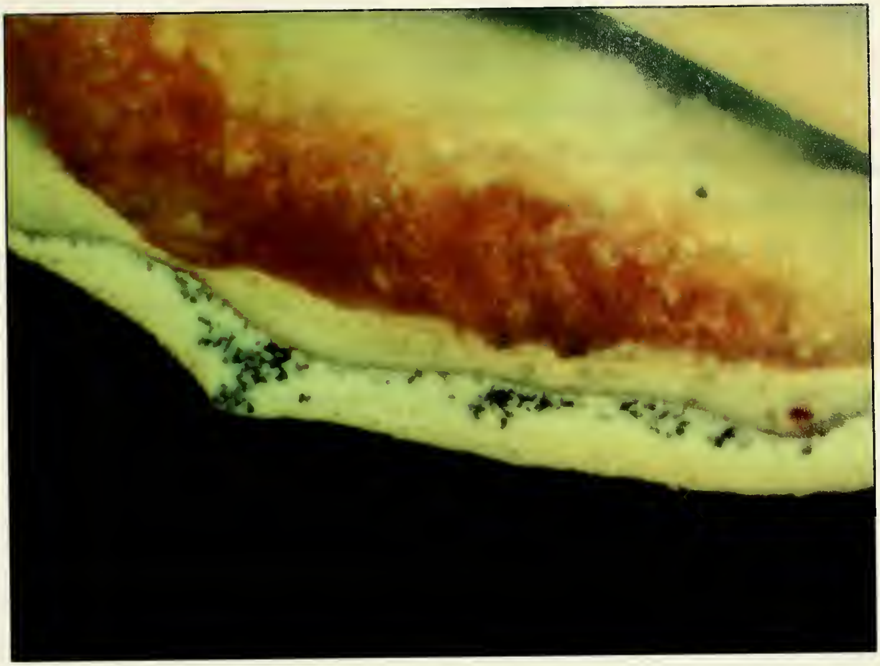

Fig. 20. Sample GH 61 at 5X, using ultraviolet light and filter cubes for autofluorescent qualities. (Photograph by Rytna Fourie and the author, 2003.)

material that fills or dresses porous materials."[59] As a large portion of the Great Hall's surfaces were created in a gypsum plaster, they would have required an application of a sizing material. This step of sizing plaster was to avoid contamination or infiltration of oils into the plaster substrate, and both shellac and glues were the most common materials used for sizing.[60] In review of the samples' stratigraphies, the intensity of this resinous coating varied to some degree, but it is possible that the dilution of the shellac was inconsistent throughout the space. Shellac was often diluted with alcohol or had oleo-

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[59] Rutherford J. Gettens and George L. Stout, *Painting Materials, a Short Encyclopedia* (New York: Dover Publications, 1966), 62.

[60] Brian Powell, "Painting Techniques: Surface Preparation and Application," in *Paint in America: The Colors of Historic Buildings*, ed. Roger W. Moss (New York: John Wiley and Sons, Inc., 1994), 217.

resins added to provide more elasticity. Examples of such resins are sandarac, mastic, and Manila copal.[61]

This resinous layer applied to the gypsum plaster of the Great Hall was then further analyzed utilizing solubility tests. These tests included placing extractions using a tungsten needle of this finish onto separate glass micro-slides and dropping ammonium hydroxide (NH_4OH), ethyl alcohol (C_2H_5OH), and acetone (CH_3COCH_3) onto each slide. The ammonium hydroxide and acetone did not show signs of altering the scrapings, while the ethyl alcohol appeared to partially dissolve the particles. This however, was not completely conclusive since its solubility was minimal and difficult to interpret, yet it was consistent with the solubility properties of shellac.

Within each layer, a tungsten needle was again used to extract pigment particles for analysis. The pigment particles were placed on glass microslides and dispersions made to compare them with reference library samples for similarities. The shape, size, and coloration within the first two layers were consistent with white lead, while the primer and finish coat of the last paint campaign resembled titanium.

Utilizing UV light again to determine the autofluorescence characteristics of the paint layers, the first two did impart a dull white glow while the last two were slightly brighter white. A bright white fluorescence is characteristic of both white lead and titanium dioxide, therefore the findings were not particularly helpful.

Additional particles were extracted from each layer for solubility testing to further determine the compositions of the paints. Again ammonium hydroxide, ethyl alcohol, and acetone were applied to each glass micro-slide. The ammonium hydroxide appeared to alter the first finish layer, which may have included linseed oil. A reaction with the ammonium hydroxide is indicative to drying oils; however the results were not definitive.

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[61] Gettens and Stout, *Painting Materials, a Short Encyclopedia*, 61.

Methylene chloride (CH_2Cl_2) was then added to the list of solvents used, which appeared to solubalize and re-form a film which could suggest an oil or oil-alkyd-resin paint finish.[62] The other layers in combination with the solvents did not result in any definitive information regarding their composition. Unfortunately, the solubility tests run on the aged paint finishes were difficult to interpret and therefore were inconclusive.
Further analytical analyses discussed in this thesis, SEM-EDS and MFTIR, would verify some of the initial findings from the pigment and media tests. These more in depth analytical techniques would produce more conclusive and definitive results.

[62] Krotzer, "St. Alphonsus Church, New Orleans, Louisiana: Documentation, Analysis and Interpretation of Interior Finishes", 136.

2.3.3
SEM-EDS and MFTIR Analysis

To verify the hypotheses on pigment and binding materials used in each layer, more in depth analytical analyses were conducted. Two methods utilized were Scanning Electron Microscopy – Energy Dispersion Spectroscopy (SEM-EDS), conducted in the Laboratory for Research on the Structure of Matter (LRSM) at the University of Pennsylvania, and Fourier Transform Infrared Micro-Spectroscopy (MFTIR), conducted at the Analytical Laboratory of the Philadelphia Museum of Art. Used in combination, these methods were critical in identifying and verifying the initial findings.

"SEM is basically a "reflecting" microscope that uses electrons instead of light photons to illuminate the object. X-rays generated can be identified by either energy-dispersive or wave-length dispersive analyzers and provide elemental composition of the sample."[63] Two representative samples, GH14 and GH82 were prepared in the BioPlastic resin, sectioned with the Buehler Isomet diamond blade, placed on an aluminum stub and coated with carbon paint. The carbon coating was necessary to provide conductivity to the sample, therefore allowing the electrons to dissipate properly.[64] Unlike the other samples prepared, the samples for the SEM-EDS were not polished with the Buehler Micro-polish II, 0.05 micron alumina powder, due to possible contamination and inaccurate results.

Sample GH82, which had a gypsum substrate, was taken from the flower petal of the archway bracket, approximately thirty-six feet from the floor. Several points were selected on the prepared cross section, where specific information was targeted for

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[63] Lecture notes from the Advanced Architectural Conservation Science course, A. Elena Charola, University of Pennsylvania, 2002.

[64] SEM-EDS was conducted by James Ferris, Ph.D. and Kevin Macke at LRSM.

collection. The first point selected for testing was the substrate. Characteristic of gypsum ($CaSO_4 \cdot 2H_2O$), were the calcium and sulfur peaks which was recorded.

The next layer targeted was the first paint layer seen in the cross section which was recorded as beige in color. This layer had large amounts of lead (Pb) and small amounts of strontium (Sr). The lead was linked to the presumption that the first paint layer was a white lead pigment. The strontium that appeared is from strontium oxide (SrO), which is a grayish-white in color and can be used in the manufacture of greases, soaps, and more importantly – pigments.[65]

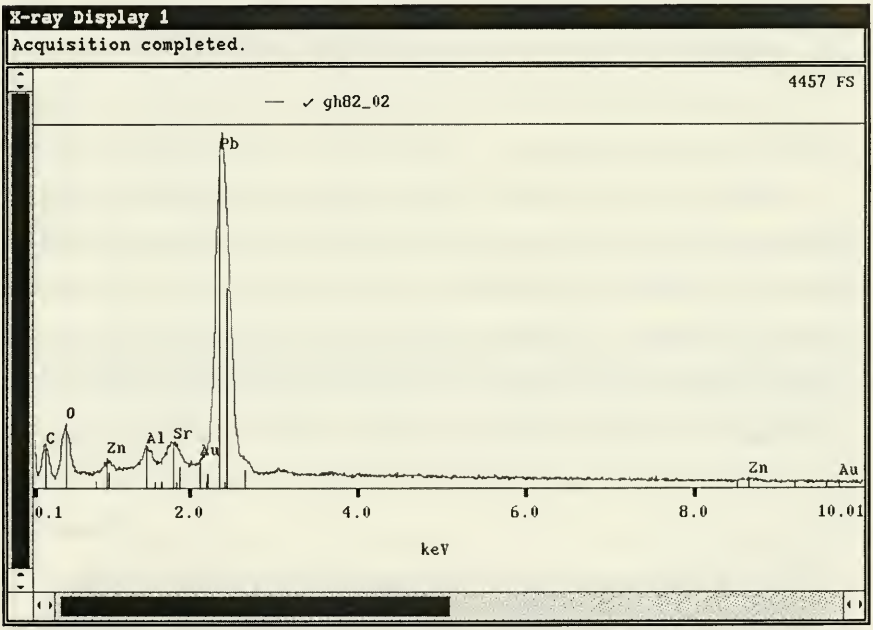

Fig. 21. Sample GH 82, layer 1 SEM-EDS data indicating lead, with small peaks of stronium, zinc, oxygen and aluminum. (Graph courtesy of LRSM at the University of Pennsylvania, 2003.)

[65] N. Irving Sax and Richard J. Lewis, *Hawley's Condensed Chemical Dictionary*, 11 ed. (New York: Van Nostrand Reinhold Company, 1987), 1099.

The second point selected was within the dirt layer in order to verify that this layer was soot and not another finish layer. The information gathered at this point is inconclusive of the make-up of this layer, with a few peaks for sulfur (S) and carbon (C). The second paint layer was incorporated in many cases with the dirt layer. Therefore, the SEM-EDS information was common with the dirt layer and the first paint layer, whereas the elements represented a similar white lead coating.

The third area targeted was the modern primer coat (See Figure 22). This layer was presumed and verified to have a titanium white pigment, which is titanium dioxide (TiO_2). Titanium dioxide was commercially introduced in the United States in 1919[66] and is "the whitest and has the greatest hiding power of any of the white pigments…As a pigment, it is non-reactive with drying oils and is a poor drier; hence, it gives soft paint films unless zinc oxide or a drier is added."[67] The addition of zinc oxide (ZnO) is apparent in the SEM-EDS information, therefore verifying the previous statement. A small peak of aluminum (Al) is also present in this layer which could be from aluminum stearate ($Al(C_{18}H_{35}O_2)_3$. Aluminum stearate is a white powdery metallic soap that is used in paints to help prevent the oil and pigment from separating.[68] Another possible reason for the aluminum presence within the sample is a hydrated silicate of aluminum, which is china clay or kaolinite. Kaolin or kaolinite ($Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$) is often used as an extender or a "white bole" for gilding and has excellent plasticity properties when mixed with water.[69]

The final paint layer analyzed uncovered yet another layer of a titanium white based coating. It is also important to note that titanium dioxide is often detected with calcium (Ca) and sulfur (S) elements, indicative of TiO_2+$CaSO_4$. This is why it is present

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[66] Walter C. McCrone, "Polarized Light Microscopy in Conservation: A Personal Perspective," *Journal of the American Institute for Conservation*, no. 33 (1994).
[67] Gettens and Stout, *Painting Materials, a Short Encyclopedia*, 161.
[68] Ibid., 93.
[69] Ibid., 105.

in the targeted collection points in the SEM-EDS data of both the primer and finish paint layers.[70] Also present in the final layer as well as the primer is magnesium (Mg) and silicon (Si). The combination of these elements suggests a form of hydrous magnesium silicate ($Mg_3Si_4O_{10}(OH)_2$), more commonly known as talc, which is used in paints as an extender or filler.[71]

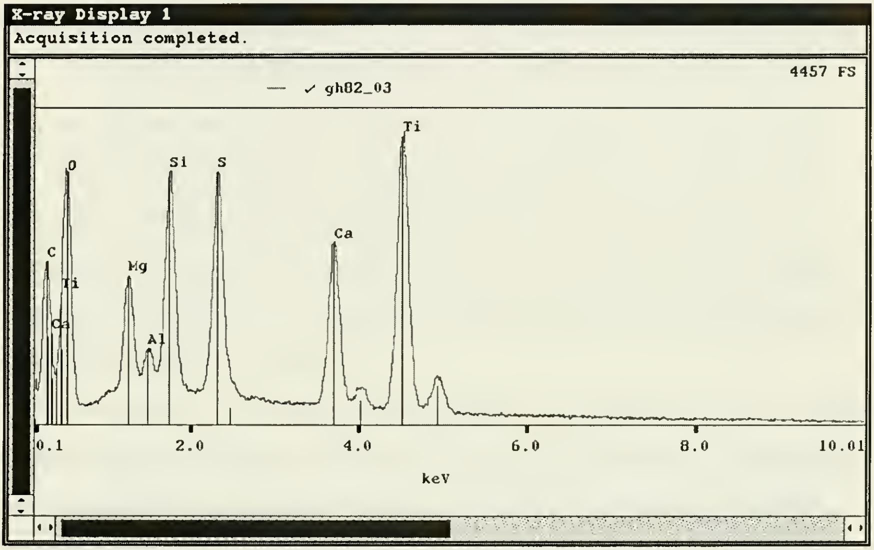

Fig. 22. Sample GH 82, layer 3, SEM-EDS data indicating large peaks of titanium, silicon, sulfur, calcium and oxygen. Smaller peaks of aluminum, and magnesium. (Graph courtesy of LRSM at the University of Pennsylvania, 2003.)

When analyzing another representative sample, similar information was gathered from SEM-EDS. Sample GH14 was taken from the north pilaster, guilloche molding approximately eighty-two inches from the floor and had a gypsum substrate. The first layers were lead based white finishes, while the last two coatings were titanium white based. Both samples also shared similar characteristics of containing aluminum, zinc, magnesium, silica, carbon, and sulfur components. The differences between the two

[70] Ibid., 147.

[71] Ibid., 160.

samples were the great height variations of the sample locations and the visual distinction in cross section of the first and second lead-based layers.

Analysis performed using SEM-EDS proved to be very helpful in identifying the elemental composition of the samples, which in turn was necessary information for further study and using MFTIR. By utilizing both these techniques, the realization that the finish layers on both the upper and lower elevations did not differ was more apparent.

To understand and document the binding material within the paint layers of the Great Hall, the same representative samples, GH14 and GH82 were analyzed with MFTIR.[72] MFTIR is the principle on which most "compounds absorb infrared energy, giving rise to a set of peaks that are considered definitive enough to be fingerprints." Identification of an unknown sample is a comparison of data from a reference standard with that of the sample. The resulting data is displayed as spectrum with absorbency or transmittance bands versus energy."[73]

Both samples were tested by taking scrapings of un-mounted sections. The layers in the samples were isolated to represent each finish layer and substrate. A few particles were then placed on a diamond cell, flattened, and situated on the stage of the infrared microscope.

As with the SEM-EDS analysis, the first layer of each sample studied was the substrate. In cases, GH14 and GH82 the spectra of gypsum were acquired, therefore verifying the SEM-EDS results (See Figure 23). The next layer studied in sample GH14, was the first paint layer, which was a white lead based coating. The MFTIR spectra not only showed that there was in fact lead white pigment, but it further characterized it as having both forms of the pigment, basic ($2PbCO_3 \cdot Pb(OH)_2$) and neutral lead carbonate ($PbCO_3$) (See Figure 24). In both samples, a spectral subtraction was undertaken to

[72] MFTIR was conducted in the Analytical Laboratory at the Philadelphia Museum of Art, by Senior Scientist, Beth A. Price.

[73] Eugene Farrell, "Pigments and Media: Techniques in Paint Analysis," in *Paint in America: The Colors of Historic Buildings*, ed. Roger W. Moss (New York: John Wiley and Sons, Inc., 1994), 198.

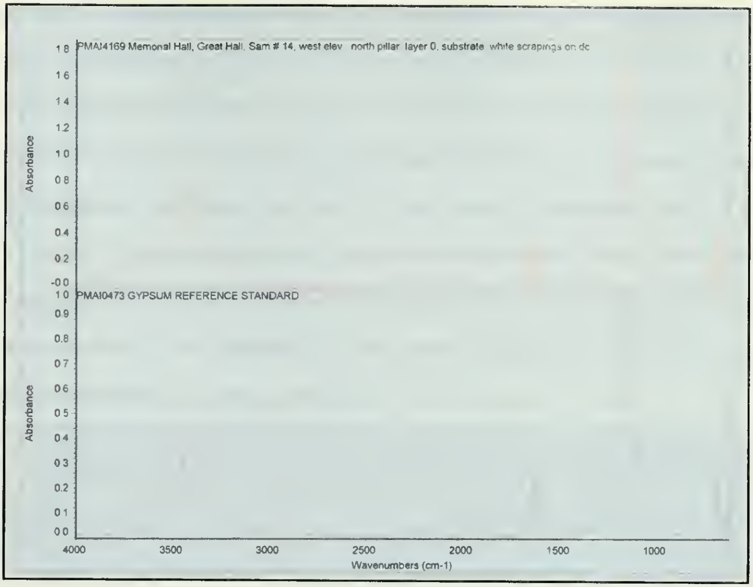

Fig. 23. Sample GH 14, MFTIR data of substrate layer. (Graph courtesy of the Analytical Laboratory at the Philadelphia Museum of Art, 2003.)

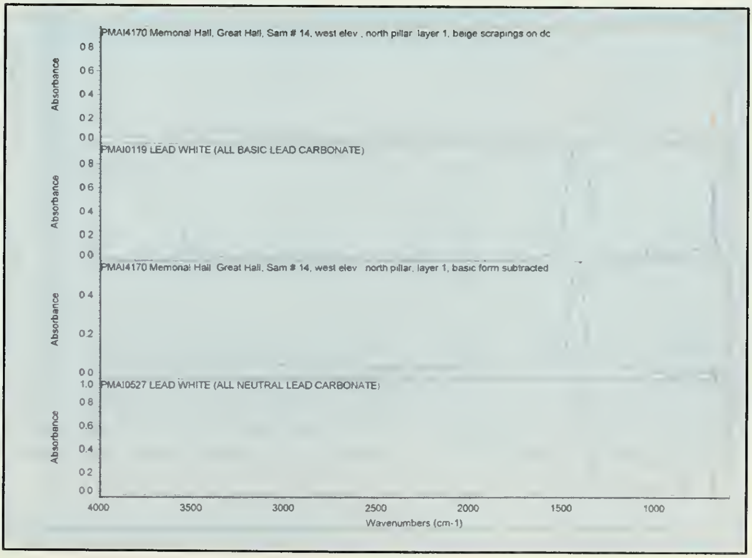

Fig. 24. Sample GH 14, MFTIR data of first layer, indicating both forms of lead. (Graph courtesy of the Analytical Laboratory at the Philadelphia Museum of Art, 2003.)

characterize the binding media within the white lead layers. By subtracting the bands for both forms of lead white, the resulting spectrum matched will with reference spectra of linseed oil and arachidic acid oleoyl ester. The main components of linseed oil are "glycerides of linolenic, oleic, linoleic, and saturated fatty acids. The drying property is due to the linoleic and linolenic groups."[74] Both oils and fats contain esters.[75] Found in both samples of layer one was oleoyl ester, which is fatty acid. While the MFTIR analysis suggested linseed oil as the medium for the first layer, it is important to note that the data is merely consistent with or comparable to linseed oil since MFTIR can not distinguish between linseed oil and other oils.

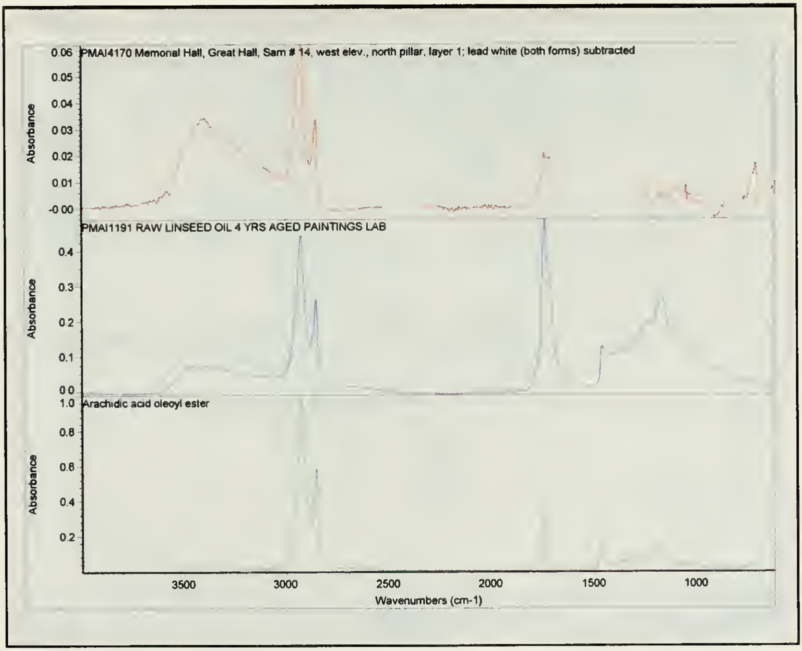

Fig. 25. Sample GH 82, MFTIR data of first paint layer, suggesting linseed oil and a fatty acid medium. (Graph courtesy of the Analytical Laboratory at the Philadelphia Museum of Art, 2003.)

[74] Sax and Lewis, *Hawley's Condensed Chemical Dictionary*, 703.

[75] Gettens and Stout, *Painting Materials, a Short Encyclopedia*, 36.

The second layer in both samples was the dirt, soot layer, and the additional lead white finish which was consistent with the original finish. The third layer was the titanium dioxide white based primer coat, which in the spectra for sample GH14 had bands constant with kaolinite, calcite, titanium dioxide, and polyvinyl acetate (PVAc). PVAc ([-$CH_2CH(OOCCH_3)$-]$_x$ is used in "latex" water paints and is resistant to weathering.[76] "Since about 1930 the vinyl resins have acquired a considerable industrial importance because certain ones can produce protective coatings which are colorless when applied and which are free from after-yellowing....They are used in the preparation of thermoplastic molding compounds as well as in coatings."[77] PVAc and acrylic

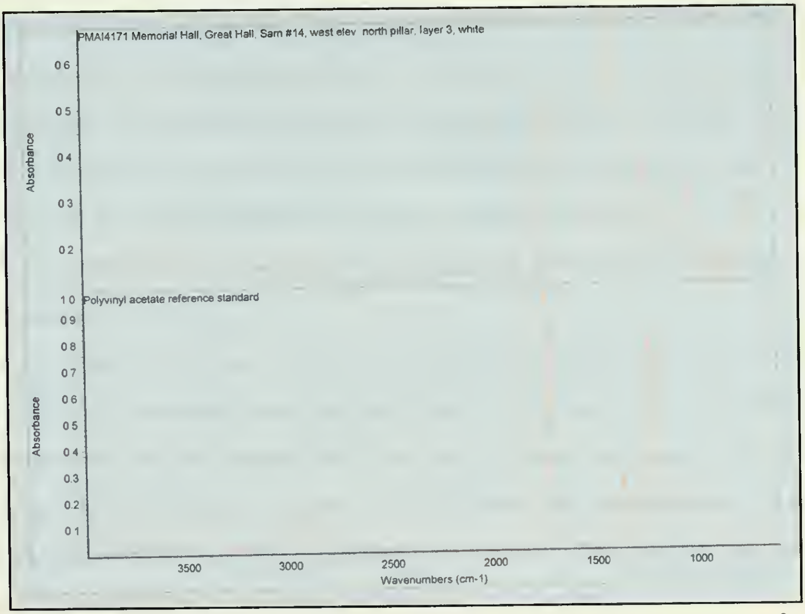

Fig. 26. Sample GH 14, MFTIR data indicating PVAc in modern primer coat. (Graph courtesy of the Analytical Laboratory at the Philadelphia Museum of Art, 2003.)

[76] Sax and Lewis, *Hawley's Condensed Chemical Dictionary*, 945.
[77] Gettens and Stout, *Painting Materials, a Short Encyclopedia*, 74.

resins that create emulsion paints, generally have increased flexibility, gloss-retention, permeability, and hardness.[78] The presence of the titanium dioxide was confirmed by the SEM-EDS analysis and therefore the hypothesis was verified. This layer was presumed to be the primer coat for the modern finish layer. However, in the third layer in sample GH82, the spectra displayed bands consistent with titanium dioxide, talc, anhydrite, and an alkyd resin (See Figure 27). Alkyd resins are similar to polyester resins and when "combined with drying oils, they are now much used in industrial preparation of paints, lacquers, enamels which are durable and flexible and do not yellow."[79] "Alkyd resins, first introduced commercially in 1928, are one of the most widely used synthetic substitutes for linseed oil-based paints because of their faster drying time, better color retention, durability, and low cost."[80] The fourth layer in both GH14 and GH82, which is the modern finish coat, had a spectrum similar to the third layer of GH82 that included the alkyd resin. This similarity is probably due to difficulty in separating the individual layers within GH82, whereby the primer layer for GH82 was not collected onto the diamond cell for the MFTIR analysis. The other possibility for the lack of PVAc in GH82 is that the primer coat may have not been applied to this area where the sample was extracted.

To identify the resinous layer that was on the gypsum substrate and prior to the first paint layer, both samples were analyzed for their composition. However, the data collected for this layer was inconclusive. The spectra produced from sample GH14, did not reveal any new information, but rather just the gypsum, anhydrate substrate, with an indication of asbestos fibers. The information from a spectral subtraction from sample GH82 referenced a copal resin mixture, but this was not definitive.

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[78] Frank G. Matero, "Paints and Coatings," in *Conserving Buildings: A Guide to Techniques and Materials*, ed. Martin E. Weaver (New York: John Wiley and Sons, Inc., 1993), 220.
[79] Gettens and Stout, *Painting Materials, a Short Encyclopedia*, 4.
[80] Matero, "Paints and Coatings," 219.

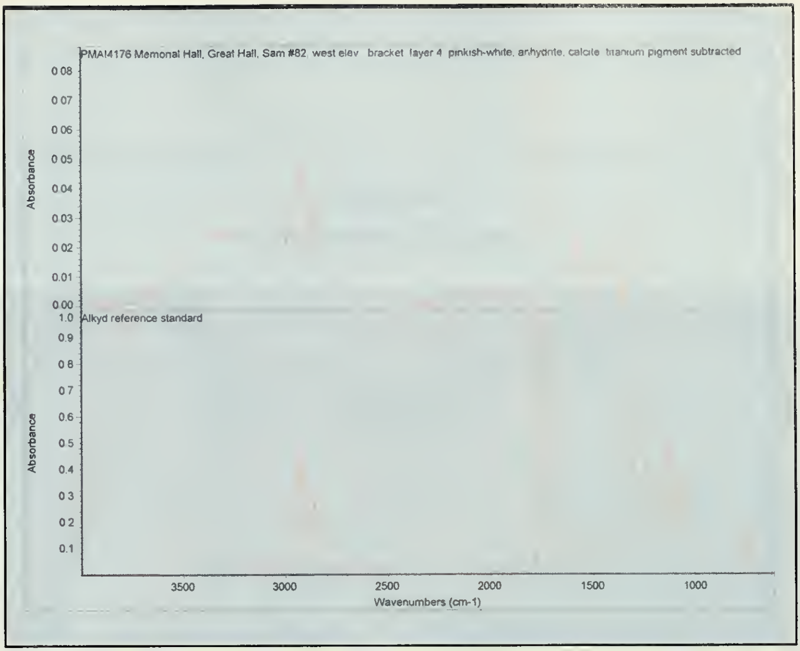


Fig. 27. Sample GH 82, MFTIR data indicating an alkyd resin in the modern finish coat. (Graph courtesy of the Analytical Laboratory at the Philadelphia Museum of Art, 2003.)

The MFTIR data was instrumental in identifying materials within these paint layers, such as calcite, basic and neutral lead white, kaolin, gypsum, anhydrite, and polyvinyl acetate. The spectral information gathered for linseed oil and the alkyd resin was consistent with or comparable to the MFTIR library references however more definitive findings could be obtained by a supplemental method such as Gas Chromatography Micro-Spectroscopy (GCMS).

In conclusion, the verification of certain presumed pigments and binding material was due to the detailed information provided by SEM-EDS and MFTIR analyses. These analytical techniques were invaluable in their ability to produce conclusive evidence of white lead, titanium dioxide, polyvinyl acetate, alkyd resins, talc, zinc, and gypsum.

Chapter 3
Interior Finishes

Fig. 28. Detail of metal ornamentation in the Great Hall. (Photograph by the author, 2003.)

Chapter 3
Interior Finishes
3.1 Conclusion

The hypothesis of the original finishes within the Great Hall was thought to be a polychromatic scheme. As previously discussed in Chapter 1.2 of this report, photographic interpretations of period images from the Centennial Photographic Company suggested darker hues and tones were located on borders, friezes, and ornamentation in the dome, however this study proved otherwise. The discrepancies in these original period images are likely due to the lighting in the room when the photographs were taken. The production of the black and white images, or stereopticons, may have altered or added to the contrast, which would also lend itself to interpretative difficulties.

This study was undertaken to determine the finishes of the entire Great Hall. Although a previous paint analysis was conducted by Frank S. Welsh in 1986-88, it was limited to areas that could be reached by the high-lift that was made available. The study conducted for this thesis extended the original analysis and included the painted metalwork of the dome. This extension was essential in completing the analysis for the entire space.

This study determined that the interior finishes of the Great Hall were:

- 1876: Gypsum plaster was primed or sized using a shellac or oleo-resin:
- ca.1876: Light yellowish gray, white lead based paint mixed with linseed oil, applied to gypsum and metal surfaces;
- 1901: Some decorative gypsum elements were treated with a gold leaf finish, while the remainder of the space was painted with another coating of the light yellowish gray lead based finish;

- 1956-1967: Titanium white based primer with polyvinyl acetate applied to the entire space, finished with a pinkish-white titanium and alkyd resin based paint. A pale blue primer and finish coat was applied only to the flat metal work surrounding the base of the dome.

In conclusion, based on photographs and documented interpretations of what was presumed to be an original polychromatic paint scheme of the hall, this thesis ultimately disproved these notions. Although a minimal decorative scheme was achieved during the early twentieth century, the Great Hall was, and continues to be, a vast light open space -- with grand decorative elements -- in a wash of a monochromatic off-white hue.

3.2
Recommendations

With the ultimate discovery that the Great Hall has historically been finished in an off-white monochromatic scheme, its future should be of the same coloration. While reviewing the paint analysis completed by Frank S. Welsh which incorporated the study of other rooms within Memorial Hall, the basic color scheme of the building appears to be one in the same with the Great Hall.

This study recommends both a respectful and traditional approach to the finishes in the Great Hall, which is to return it to the light yellowish gray cited in this thesis, or to retain the present finish, since it is in keeping with the original scheme. However, prior to any alterations to the painted surfaces, the necessary repairs must be taken to secure the roof structure from its continual water infiltration problems as well as the continuation of the plaster stabilization program. Once these campaigns have been completed, the paint restoration or re-creation could begin.

As the future of Memorial Hall is suspect, regarding its inhabitants and use, the building should continue to be open to the public. Its optimum use is as a museum or exhibition space, as this was the building's original intent. Its grand gesture on the grounds of Fairmount Park is of architectural mastery and ornamental opulence that should be accessible to both citizens and visitors alike to Philadelphia.

Appendix A

Wetherill Patent

*Image of Samuel Wetherill's 1776 business card. (Wetherill, *Samuel Wetherill and the Early Paint Industry of Philadelphia: Written for the City History Society of Philadelphia*. Philadelphia: City History Society of Philadelphia, 1916.)

Patent Information to manufacture white lead by S. Wetherill, Jr, 1811

"Lead is melted and cast so as to form a sheet about two feet and a half feet long and five or six inches in breadth, being from 1/50 to 1/60 of an inch in thickness....These plates are then rolled up into loose coils and each is placed perpendicularly in an earthen pot, peculiarly formed being large enough readily to contain the coil and having on its inner surface projections which prevent its coming in contact with the bottom of the pot, and which projections also answer the purpose of allowing a considerable portion of vinegar to be contained, without wetting the lower part of the lead. These pots are then ranged in beds under a building that shelters them from the weather, layer, upon layer, being covered with boards, and having intervening between each, fresh stable litter.

The heat of the dung acting upon the vinegar, causes it to evaporate and the lead kept constantly in contact with the acid vapor but not immersed in the liquor, soon begins to corrode or oxidate. The pots remain under the litter for about 6 weeks or 2 months at the end of which time they are taken out and the coils are found generally corroded being converted into a whitish, scaly, brittle subcarbonate.

The Wetherill method differs from the Dutch Process from this point forward.

....as the action throughout the whole bed is not equable there are generally some small portions of the metal which have not been acted upon by the acetous acid and thus escaped corrosion; these are to be carefully separated by means of a sieve. This subcarbonate is mixed with water and passed between a pair of mill stones; the finer parts are separated from the coarser by successive washings, or rather by letting the water in which this preparation is suspended flow through cisterns, the fine particles pass off, whilst those which by grinding have not been rendered sufficiently so deposit in the first cistern, and are again ground, the finer part being more readily suspended in water is deposited in the last cistern; this is to be well levitated and after the ceruse has precipitated; a sufficiency of the water is drawn off to render it fit for drying; it is then placed upon kilns and by a gradual fire all water is evaporated from it; which this is effected it then constitutes ceruse or the white lead of commerce.

To then complete the process by mixing the pigment with oil:

From this (kiln) it is conveyed to a mill and ground, into which, at this time, linseed oil is led by means of pipes. Out of the mill the white lead comes forth in its pure state, not so after exposure to the atmosphere. It is then put into kegs and barrels, and is ready for home consumption, or transportation. The smallest kegs hold twelve and a half pounds; the largest barrels fifteen hundred pounds."*

* Teresa Osterman Green, "The Birth of the American Paint Industry" (University of Delaware, 1965), 58-61.

Appendix B

Key to Sample Locations

Photograph by the author, 2003.

Sample#	Location on West Elevation	Approx. Distance from Floor	Substrate
GH 1	Central door surround, outside rail of outside panel	24"	Wood
GH 2	Central door surround, outside inset panel	98"	Wood
GH 3	Central door frame, outside rail of frame	58.5"	Wood
GH 4	Central door surround, baseboard	12"	Wood
GH 5	North pilaster, base block	49"	Gypsum
GH 6	North pilaster, base of ground wall	49"	Gypsum
GH 7	North pilaster, first bull nose	58"	Gypsum
GH 8	North pilaster, second bull nose	68"	Gypsum
GH 9	Field of ground wall for north pilaster	72"	Gypsum
GH 10	North pilaster, grape leaf of garland molding	75"	Gypsum
GH 11	North pilaster, grape shape from festoon	75"	Gypsum
GH 12	North pilaster, gourd shape from festoon	75"	Gypsum
GH 13	North pilaster, peach shape from festoon	75"	Gypsum
GH 14	North pilaster, guilloche molding	82"	Gypsum
GH 15	North pilaster, bull nose molding	83"	Gypsum
GH 16	North pilaster, edge of flute	84"	Gypsum
GH 17	North pilaster, inset of flute	13'8"	Gypsum
GH 18	North pilaster, garland around projecting face	78"	Gypsum
GH 19	North pilaster, decorative crown around face	79"	Gypsum
GH 20	North pilaster, projecting face	78"	Gypsum

GH 21	North pilaster, hemispherical pellet molding above face	80"	Gypsum
GH 22	North pilaster, below capital, pellet molding	14'	Gypsum
GH 23	North pilaster, acanthus leaves below capital	14'	Gypsum
GH 24	North pilaster, egg and dart molding below capital	14'2"	Gypsum
GH 25	North pilaster, large acanthus leaf under voluted edge of capital	14'6"	Gypsum
GH 26	North pilaster, fleuron of capital	14'6"	Gypsum
GH 27	North pilaster, top edge of capital	14'9"	Gypsum
GH 28	Lower cornice, first flat band	15'	Gypsum
GH 29	Lower cornice, bead and reel molding	15'5"	Gypsum
GH 30	Lower cornice, second flat band	16'	Gypsum
GH 31	Lower cornice, fleur-de-lis	19'	Gypsum
GH 32	Lower cornice, third flat band	20'	Gypsum
GH 34	Lower cornice, acanthus leaf molding	20'5"	Gypsum
GH 35	Lower cornice, fifth flat band	21'	Gypsum
GH 36	Lower cornice, egg and dart molding	23'	Gypsum
GH 37	Lower cornice, sixth flat band	23'5"	Gypsum
GH 38	Lower cornice, bead and reel molding	23'7"	Gypsum
GH 39	Lower cornice, acanthus leaf molding	23'9"	Gypsum
GH 40	Lower cornice, top edge of seventh flat band	24'	Gypsum
GH 41	South side of north pilaster, pellet molding – from pellet	23'6"	Gypsum
GH 42	South side of north pilaster, pellet molding – field	23'6"	Gypsum
GH 43	Block base of caryatid	25'	Gypsum

GH 44	Edge of toe from caryatid	26"	Gypsum
GH 45	Drapery at knee of caryatid	30'	Gypsum
GH 46	Archway molding, north of caryatid, outermost ring (#1)	34'	Gypsum
GH 47	Archway molding #2	34'	Gypsum
GH 48	Archway molding #3 –half-round	34'	Gypsum
GH 49	Archway molding #4 – flat band	34'	Gypsum
GH 50	Archway molding #5 – quarter-round	34'	Gypsum
GH 51	Archway molding #6 – flat band	34'	Gypsum
GH 52	Archway molding #7 – bead	34'	Gypsum
GH 53	Archway molding #8 – flat band	34'	Gypsum
GH 54	Arm of caryatid	36'	Gypsum
GH 55	Hair of caryatid	36'5"	Gypsum
GH 56	Flower petal in hair of caryatid	36'5"	Gypsum
GH 57	Flat cap above caryatid	37'	Gypsum
GH 58	Bead molding above caryatid	37'	Gypsum
GH 59	Ogee molding below bracket	37'5"	Gypsum
GH 60	Half-round molding below bracket	37'5"	Gypsum
GH 61	Acanthus leaf of bracket	38'	Gypsum
GH 62	Edge of volute from bracket	38'	Gypsum
GH 63	Inset edge of volute from bracket	38'	Gypsum
GH 64	Pellet molding around volute of bracket	38'	Gypsum
GH 65	Ovolo molding of bracket	38'	Gypsum
GH 66	Underside of projected cornice	38'	Metal
GH 67	Fleur-de-lis panel molding on underside of projected cornice	38'	Metal
GH 68	Field of inset panel from underside of projected cornice	38'2	Metal

GH 69	Flat border around panel from underside of projected cornice	38'2"	Metal
GH 70	Bead and reel molding	38'8"	Metal
GH 71	Flat border above bead and reel molding	38'9"	Metal
GH 72	Ovolo molding below ceiling of projected cornice	38'9"	Metal
GH 73	Ceiling of projected cornice	38'10"	Drywall
GH 74	Archway molding #9 - edge	34'	Gypsum
GH 75	Archway molding #10 – flat band	34'	Gypsum
GH 76	Archway molding #11 – ogee band	34'	Gypsum
GH 77	Archway molding #12 – inset panel	34'	Gypsum
GH 78	Raised triangular panel next to caryatid	36'	Gypsum
GH 79	Ovolo molding around triangular panel next to caryatid	36'	Gypsum
GH 80	Outermost ovolo molding around triangular panel next to caryatid	36'	Gypsum
GH 81	Edge of volute from archway bracket	36'	Gypsum
GH 82	Flower petal from archway bracket	36'	Gypsum
GH 83	Base of volute	36'	Gypsum
GH 84	Acanthus leaf from archway bracket	36'	Gypsum
GH 85	Festoon of archway bracket	36'	Gypsum
GH 86	Field of shell-shaped frieze	40'	Metal
GH 87	Edge of shell from frieze	40'	Metal
GH 88	Flower petal within shell frieze	40'	Metal
GH 89	Pellet molding of projecting cornice	42'	Metal
GH 90	Bottom edge ogee molding of projecting cornice	42'6"	Metal

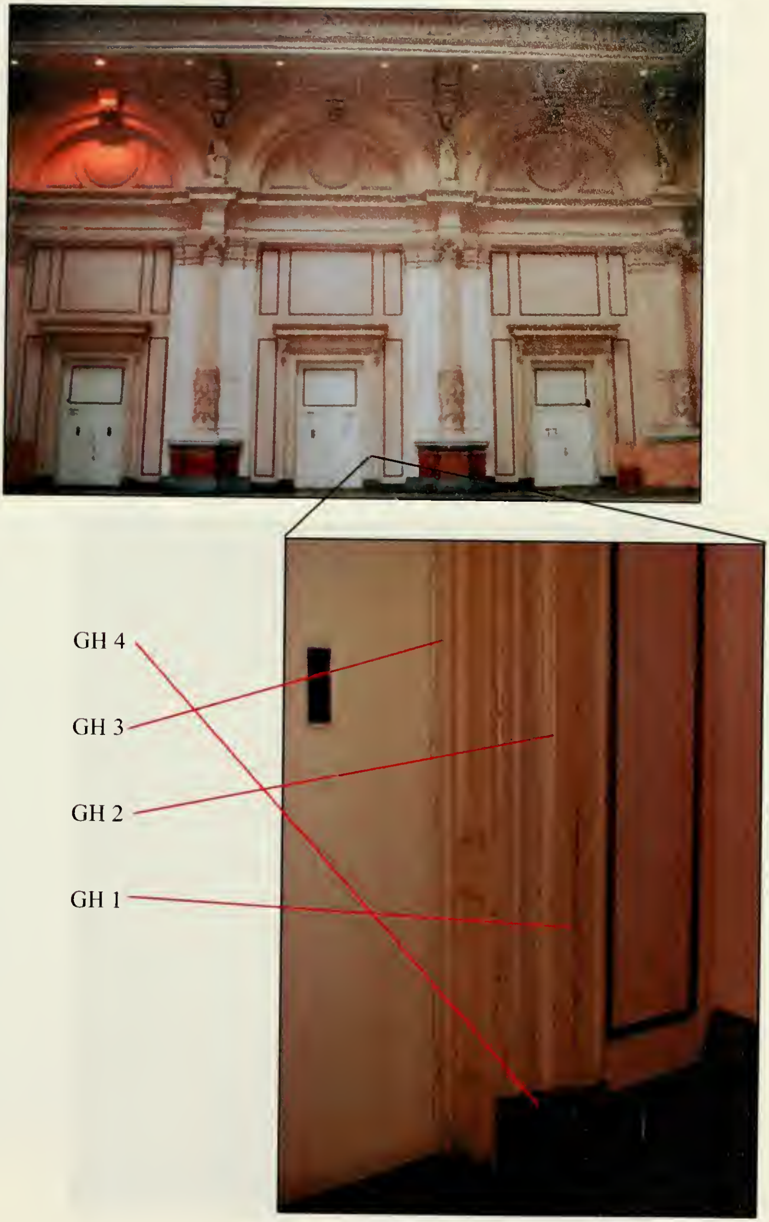
GH 91	Curved edge of ogee molding of projecting cornice	43'	Metal
GH 92	Top edge of projecting cornice	43'6"	Metal
GH 93	Field of inset curved wall (where ventilation panels are)	45'	Metal
GH 94	Flat projecting molding around inset curved wall	48'	Metal
GH 95	Guilloche molding	49'	Metal
GH 96	Flat molding above guilloche molding	50'10"	Metal
GH 97	Egg and dart molding above flat band	51'	Metal
GH 98	Flat band above egg and dart molding	52'	Metal
GH 99	Acanthus leaf frieze above flat band	52'	Metal
GH 100	Acanthus and urn frieze	52'5"	Metal
GH 101	Flat projecting band	53'	Metal
GH 102	Acanthus frieze above flat band	53'5"	Metal
GH 103	Large flat band	57'	Metal
GH 104	Acanthus frieze above large flat band	57'	Metal
GH 105	Bead molding	57'5"	Metal
GH 106	Niche and dart molding	58'	Metal
GH 107	Egg and dart molding	58'5"	Metal
GH 108	Projecting panel between brackets	59'	Metal
GH 109	Acanthus leaf from bracket	59'	Metal
GH 110	Flower petal from bracket	59'	Metal
GH 111	Volute from bracket	60'	Metal
GH 112	Underside of cornice	62'	Metal
GH 113	Edge of projecting cornice	62'	Metal
GH 114	Blue field	51'	Metal
Dome	Exterior of interior dome – iron beam		Iron

Appendix C

Visual Representation of Sample Locations

Photographs by the author, 2003.

Sample Locations



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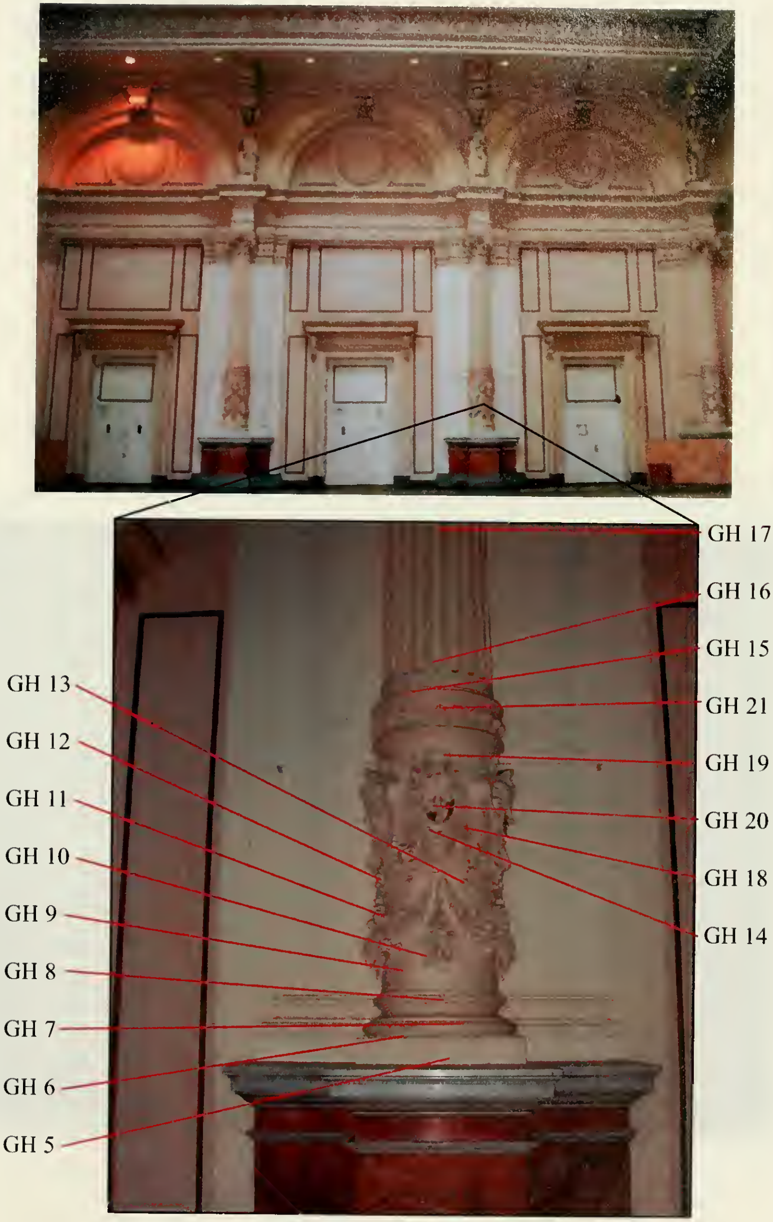
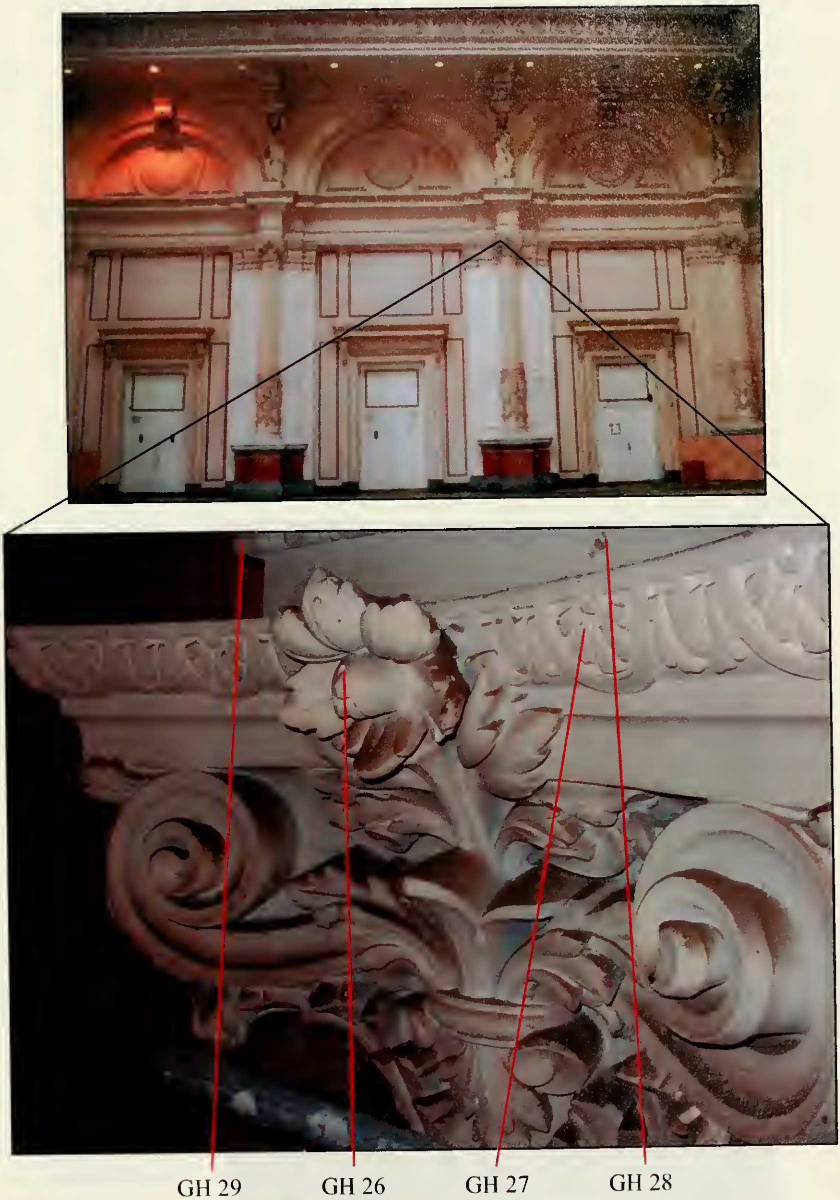


Sample Locations

Sample Locations



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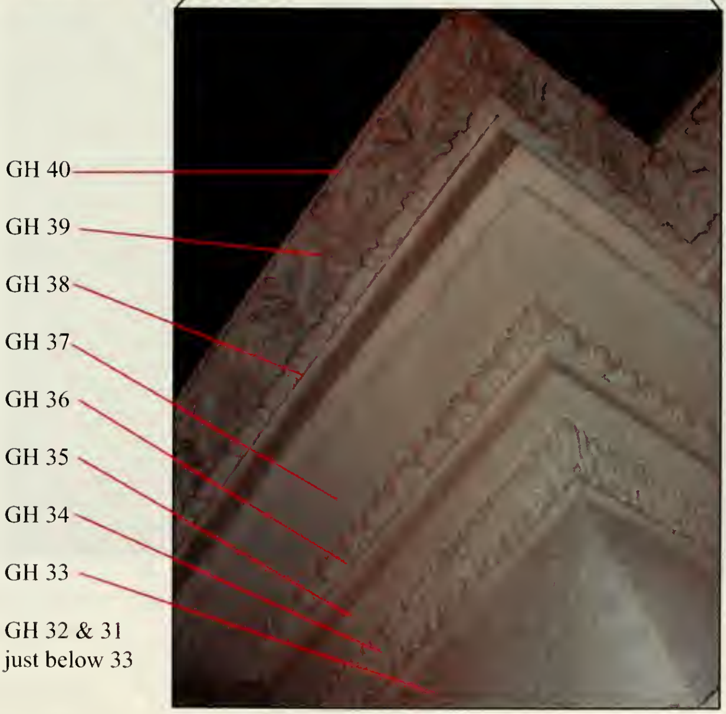
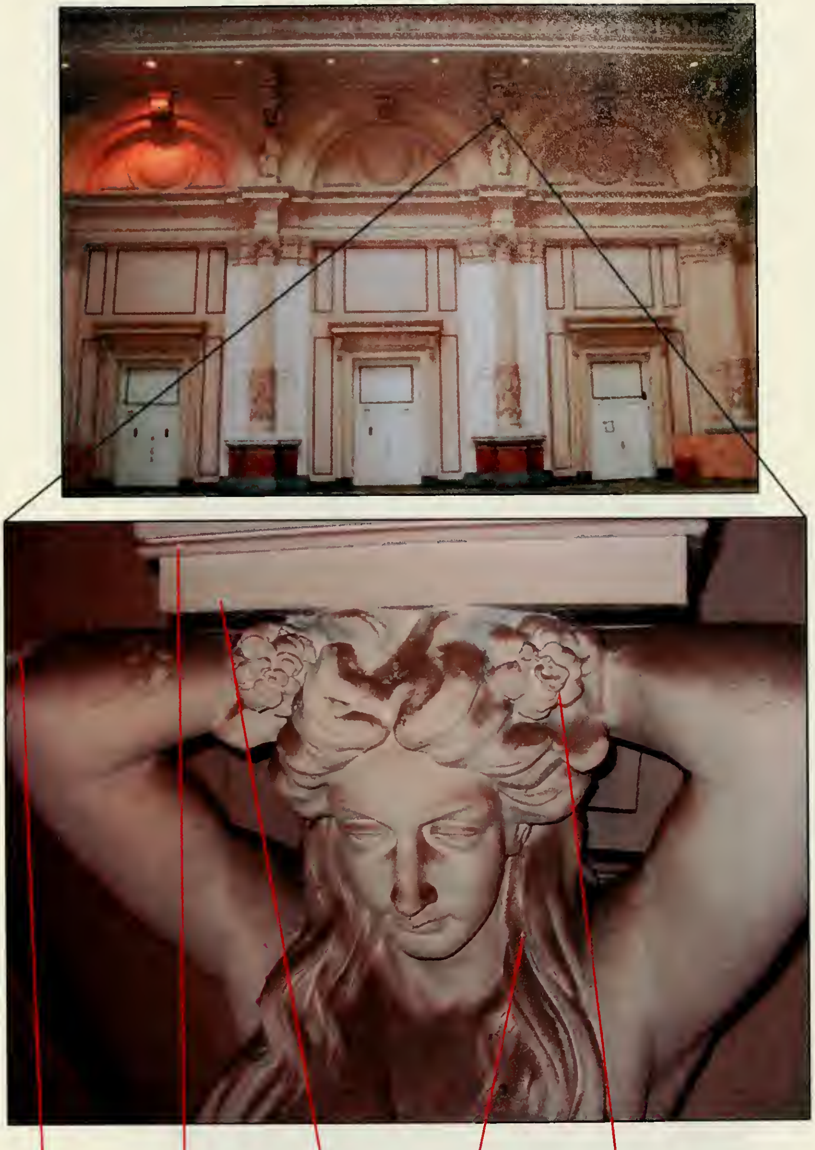
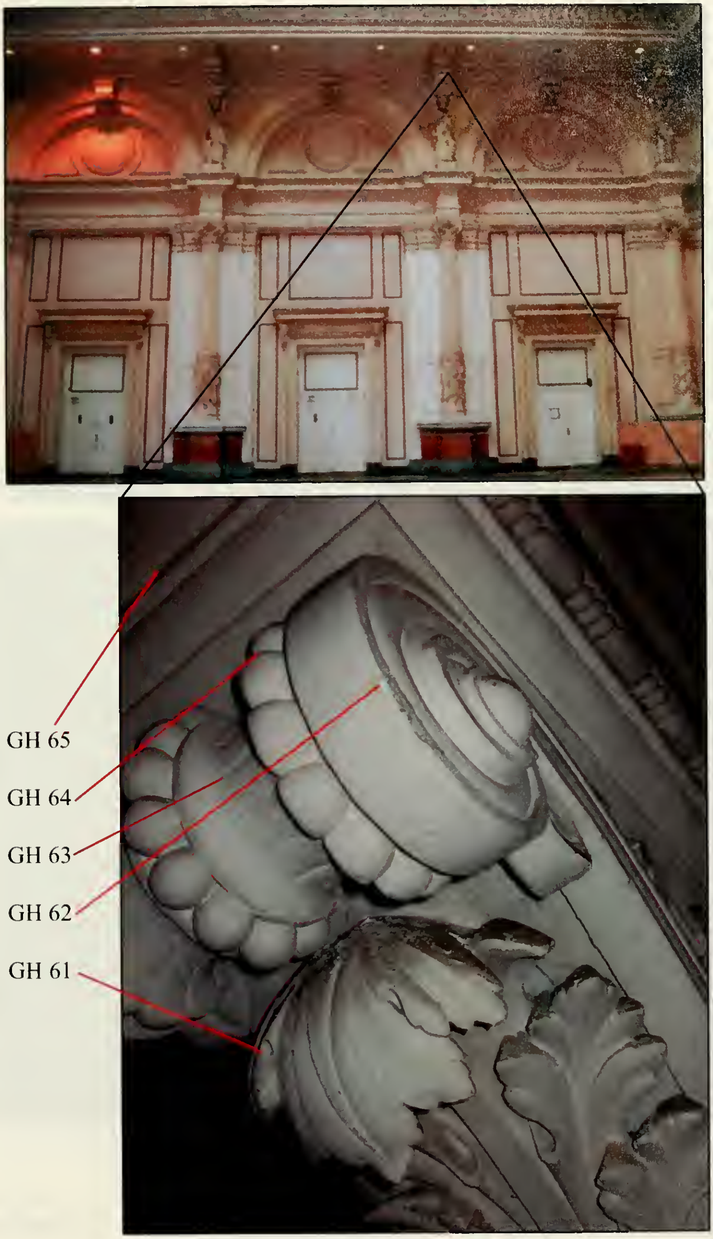


Sample Locations

Sample Locations



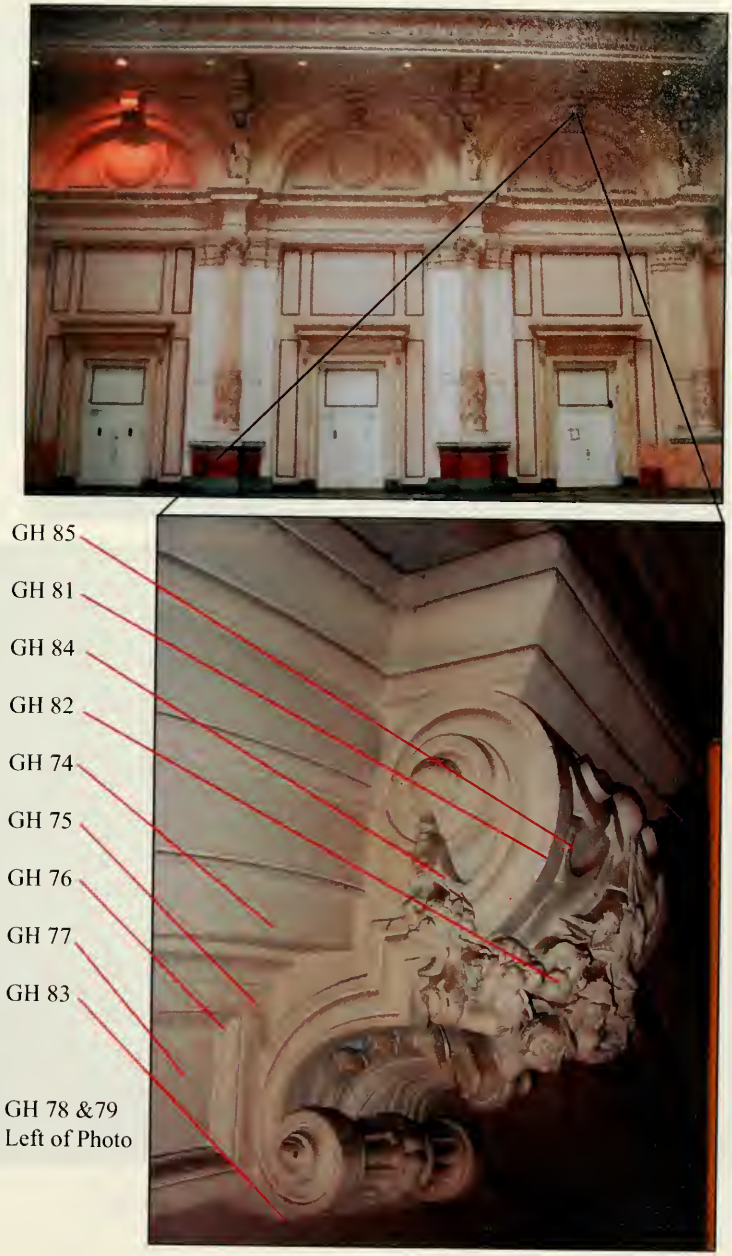

GH 65
GH 64
GH 63
GH 62
GH 61

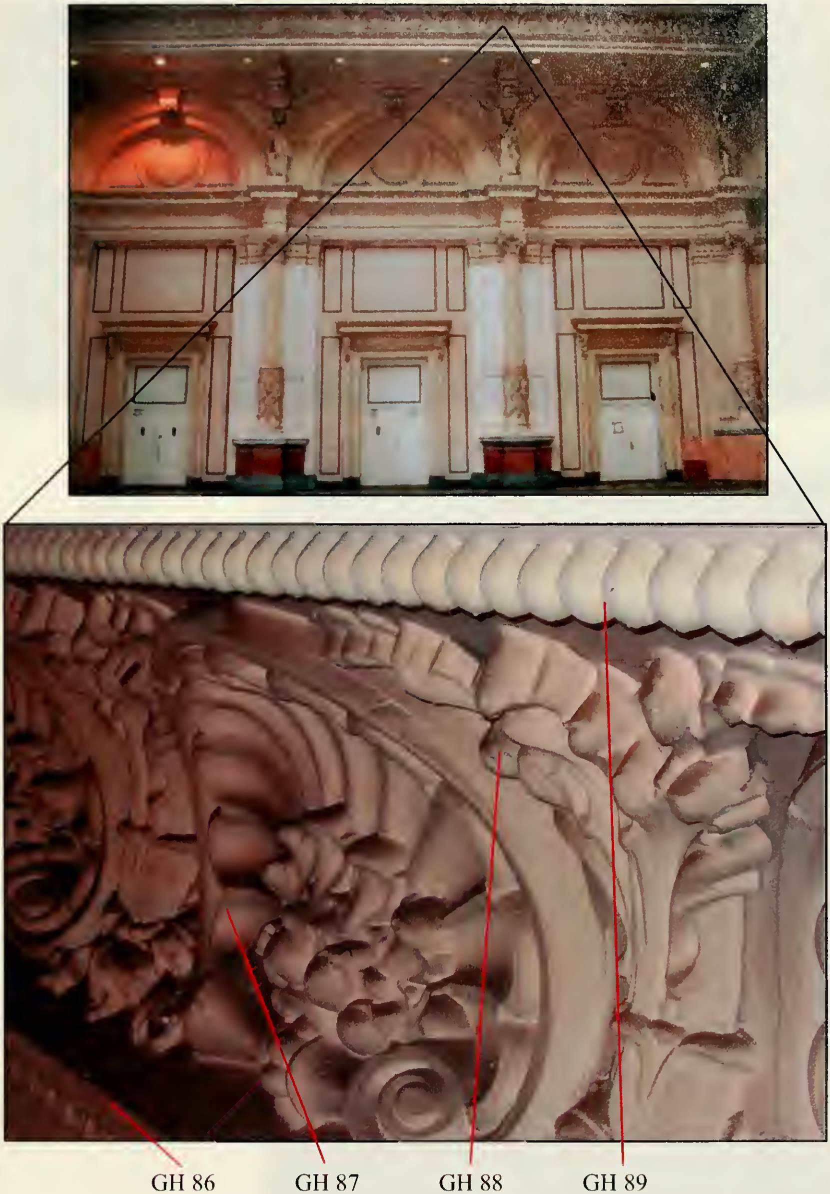
Sample Locations

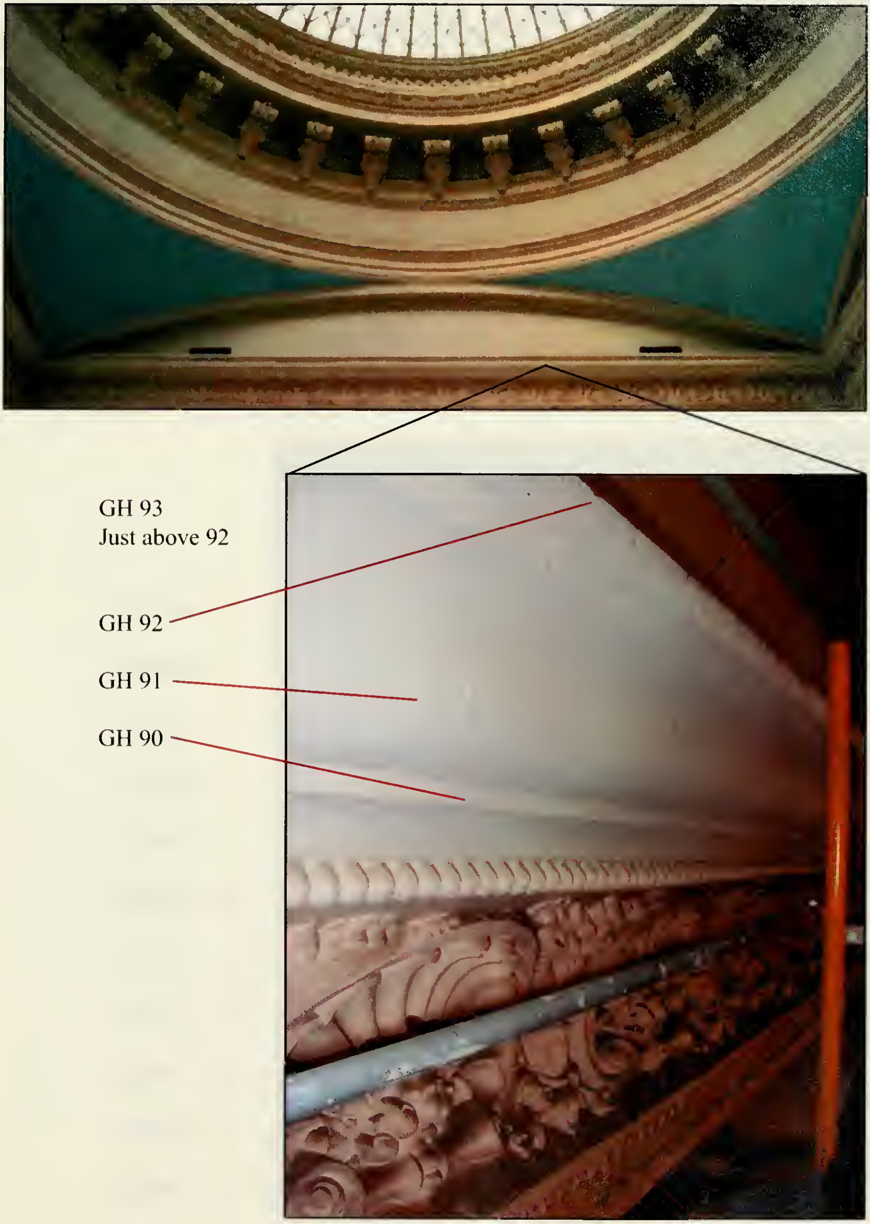
GH 67 GH 68 GH 69 GH 70 GH 71 GH 72 GH 73

GH 66
Just below 67

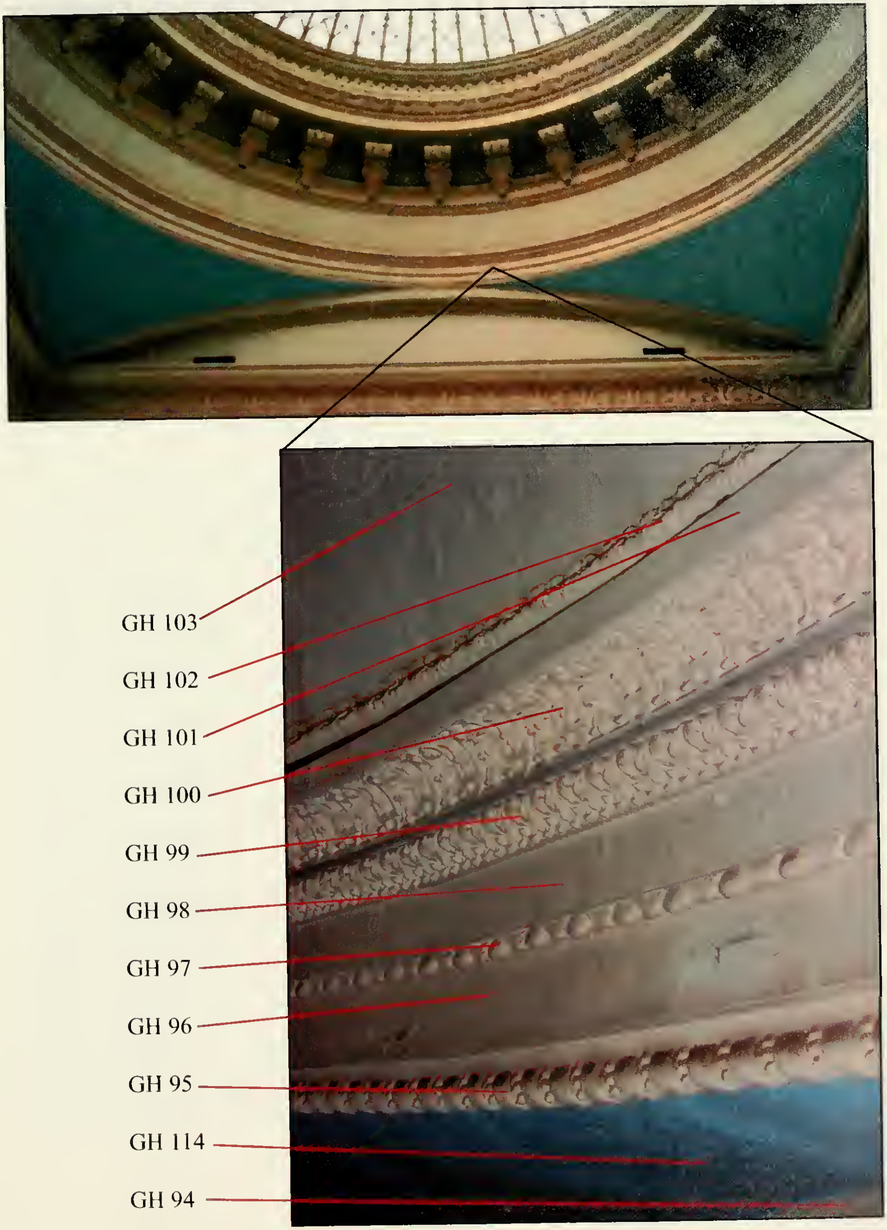
Sample Locations




GH 86
GH 87
GH 88
GH 89


GH 93
Just above 92
GH 92
GH 91
GH 90

Sample Locations



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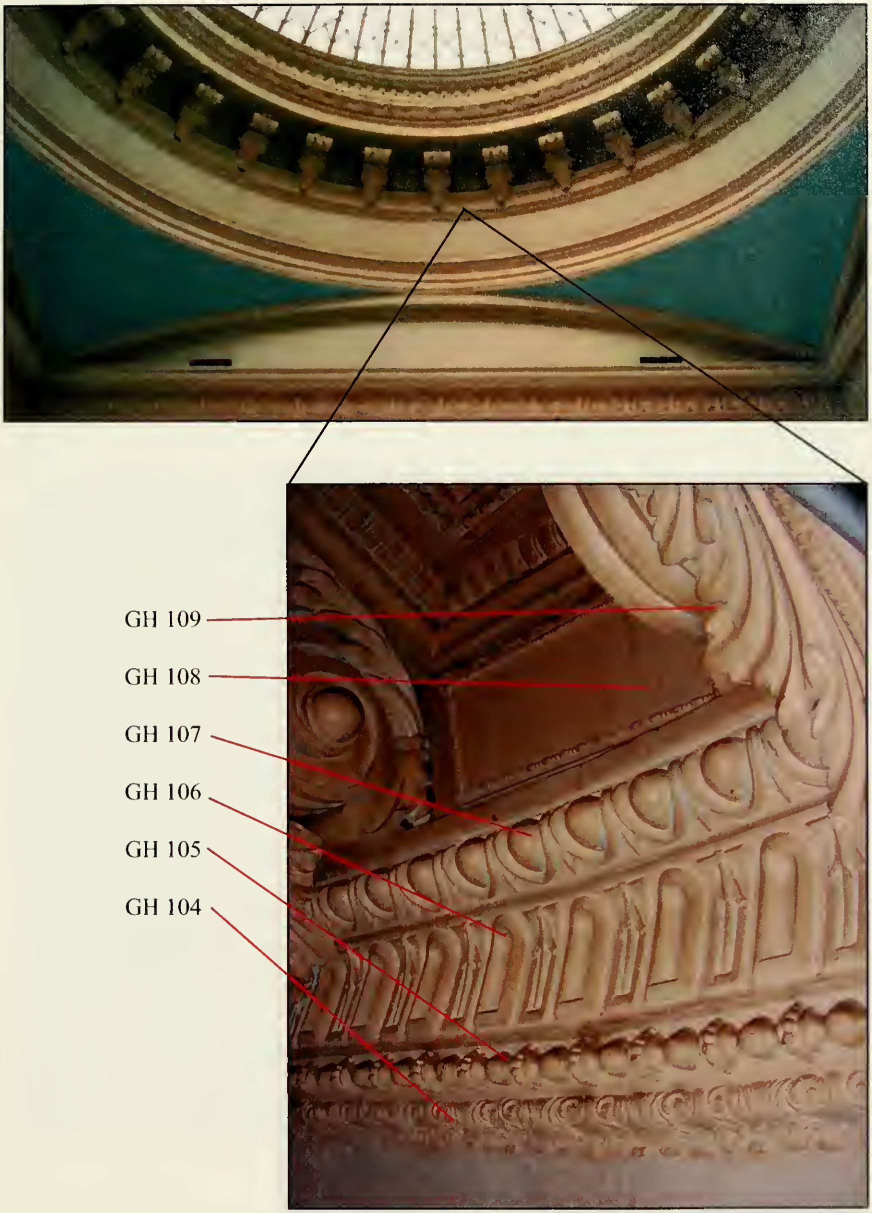
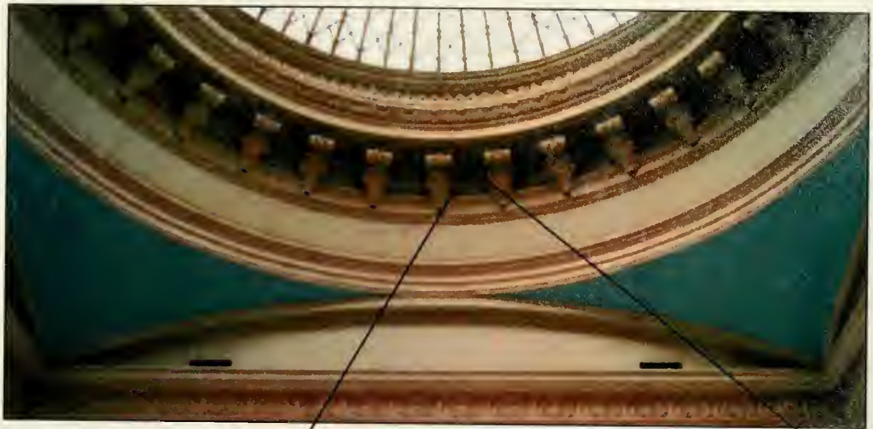


Sample Locations



Sample Locations

GH 11 GH 113

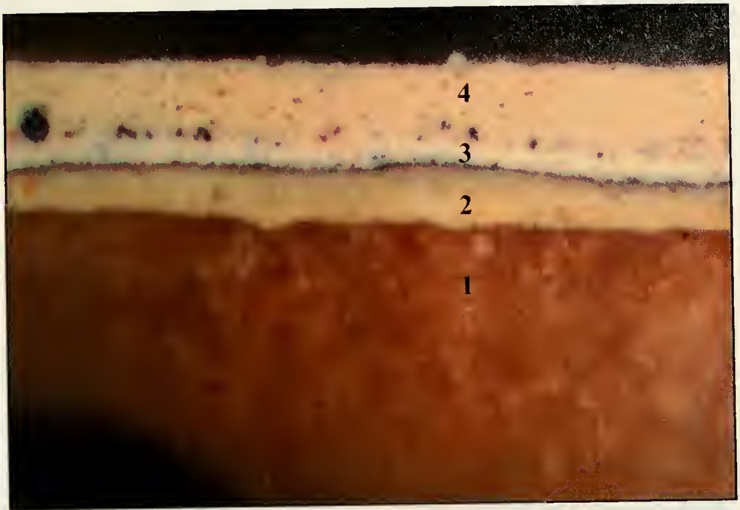
Exterior of interior dome sample taken from iron structural member.

APPENDIX D

KEY TO SAMPLE STRATIGRAPHIES

Photographs by Rynta Fourie and the author, 2003.

Note: The colors have been affected by the duplication process
and should not be treated as true representations



Sample GH 14 taken at 10X magnification.

Layers:

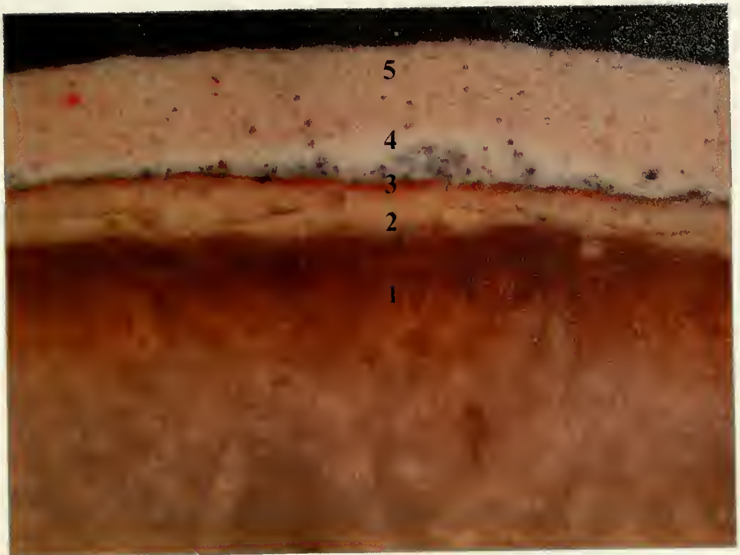
1. Resinous gypsum
2. Yellowish gray

Dirt

3. White primer
4. Pinkish white top coat

Consistent with samples:

GH 11	GH 22	GH 59
GH 12	GH 23	GH 60
GH 13	GH 24	GH 61
GH 15	GH 27	GH 62
GH 16	GH 28	GH 63
GH 17	GH 29	GH 64
		GH 65



Sample GH 26 taken at 10X magnification

Layers:

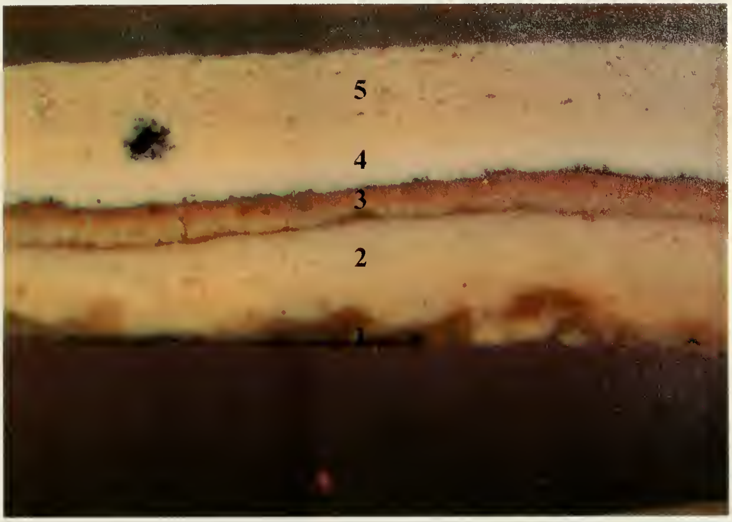
1. Resinous gypsum
2. Yellowish gray
3. Metallic gold leaf

Dirt

4. White primer
5. Pinkish white top coat

Consistent with samples:

GH 18
GH 19
GH 20
GH 21
GH 25



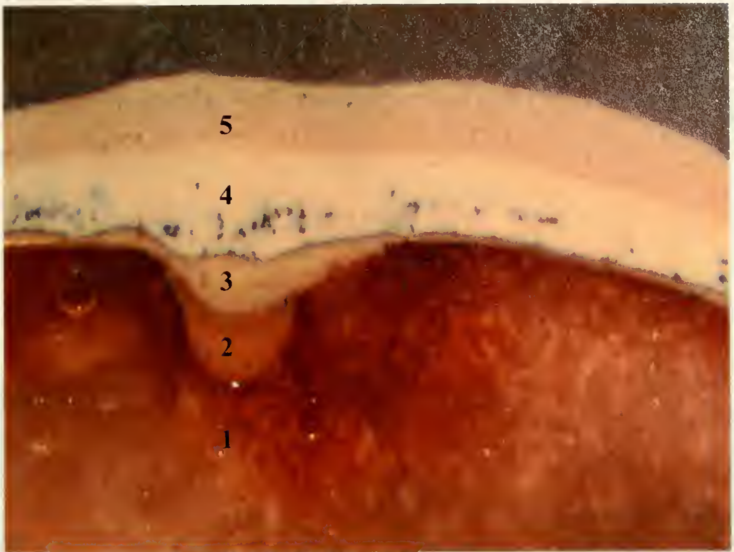
Sample GH 72 taken at 10X magnification

Layers:

1. Metal substrate
2. Yellowish gray
Break
3. Yellowish gray
4. White primer
5. Pinkish white top coat

Consistent with samples:

GH 66	GH 88	GH 96	GH 104
GH 67	GH 89	GH 97	GH 105
GH 68	GH 90	GH 98	GH 106
GH 69	GH 91	GH 99	GH 107
GH 70	GH 92	GH 100	GH 108
GH 71	GH 93	GH 101	GH 109
GH 86	GH 94	GH 102	GH 110
GH 87	GH 95	GH 103	GH 111
			GH 112



Sample GH 82 taken at 5X magnification

Layers:

1. Resinous gypsum
2. Yellowish gray mixed with resin
3. Yellowish gray

Dirt

4. White
5. Pinkish white top coat

Consistent with samples:

GH 30	GH 40	GH 50	GH 75
GH 31	GH 41	GH 51	GH 76
GH 32	GH 42	GH 52	GH 77
GH 33	GH 43	GH 53	GH 78
GH 34	GH 44	GH 54	GH 79
GH 35	GH 45	GH 55	GH 80
GH 36	GH 46	GH 56	GH 81
GH 37	GH 47	GH 57	GH 84
GH 38	GH 48	GH 58	GH 85
GH 39	GH 49		

Appendix E

Palette of Paint Schemes

Photograph by the author, 2003.

Note: The colors have been affected by the duplication process
and should not be treated as true representations.
Use color notations specified rather than matching to the color chips .

First Paint Finish (c.1876)

Description: Light Yellowish-gray

Munsell notation: 5Y 8.5/2

CIE					
L*	86.21	R	222	C	12
A*	-2.46	G	214	M	15
B*	16.29	B	183	Y	28
				K	0

Benjamin Moore: HC-30

Philadelphia Cream

Philadelphia Cream HC-30

Second Paint Finish (1901)

Description: Light Yellowish-gray

Munsell notation: 5Y 9/2

CIE

L*	91.08	R	236	C	7
A*	-2.68	G	229	M	10
B*	16.69	B	196	Y	23
				K	0

Benjamin Moore: 2151-60

Linen Sand

Third Paint Finish (1956-1967)

Description: White / Neutral Primer Coat
Munsell notation: N.9.5/90% R

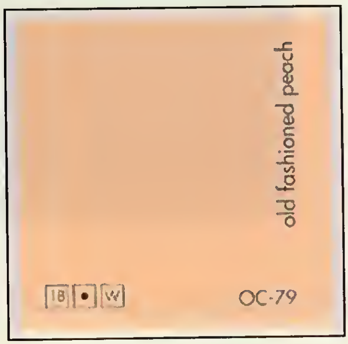
Description: Pinkish-White Finish Coat
Munsell notation: 10YR 9/1.5

CIE					
L*	91.08	R	239	C	6
A*	.97	G	227	M	10
B*	10.82	B	207	Y	18
				K	0

Primer (Benjamin Moore: Super White 02)

Finish:

Benjamin Moore: OC-79
Old Fashioned Peach



Third Paint Finish (1956-1967): Flat Tin At Base of Dome

Description: Pale Blue Primer

Munsell notation: 5B 6/4

CIE

L*	61.70	R	109	C	42
A*	-12.15	G	154	M	25
B*	-11.89	B	168	Y	20
				K	14

Benjamin Moore: 071-725

Seaside Resort

Third Paint Finish (1956-1967): Flat Tin At Base of Dome

Description: Pale Blue Finish Coat

Munsell notation: 5B 7/4

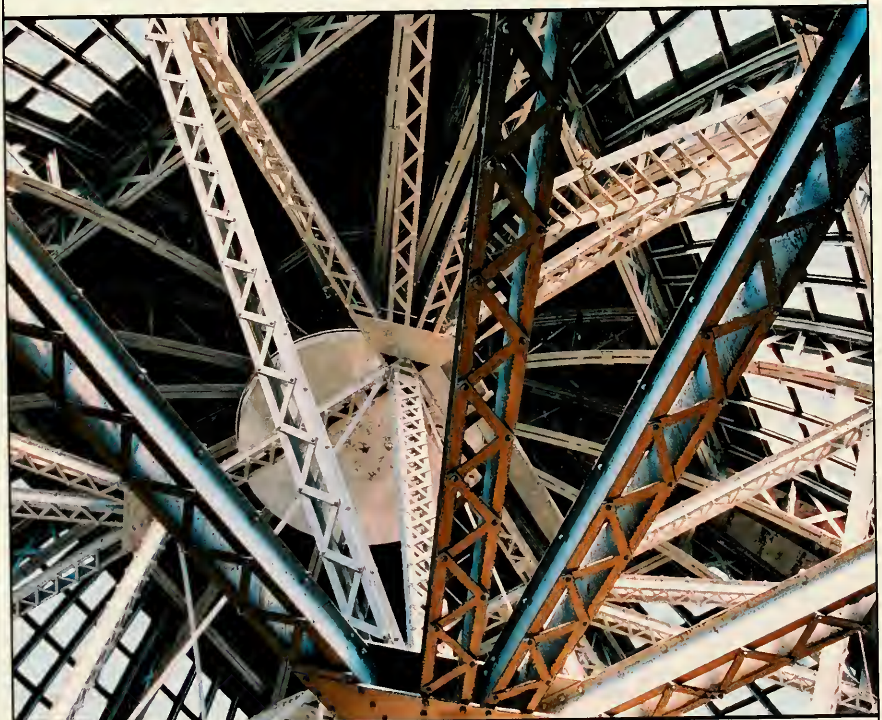
CIE

L*	71.60	R	134	C	43
A*	-12.58	G	181	M	25
B*	-11.70	B	194	Y	20
				K	3

Benjamin Moore: 071-724

Peacock Feathers

Bibliography



Structural iron-work between the interior and exterior domes of Memorial Hall.
Photograph by the author, 2003.

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